Technology Review

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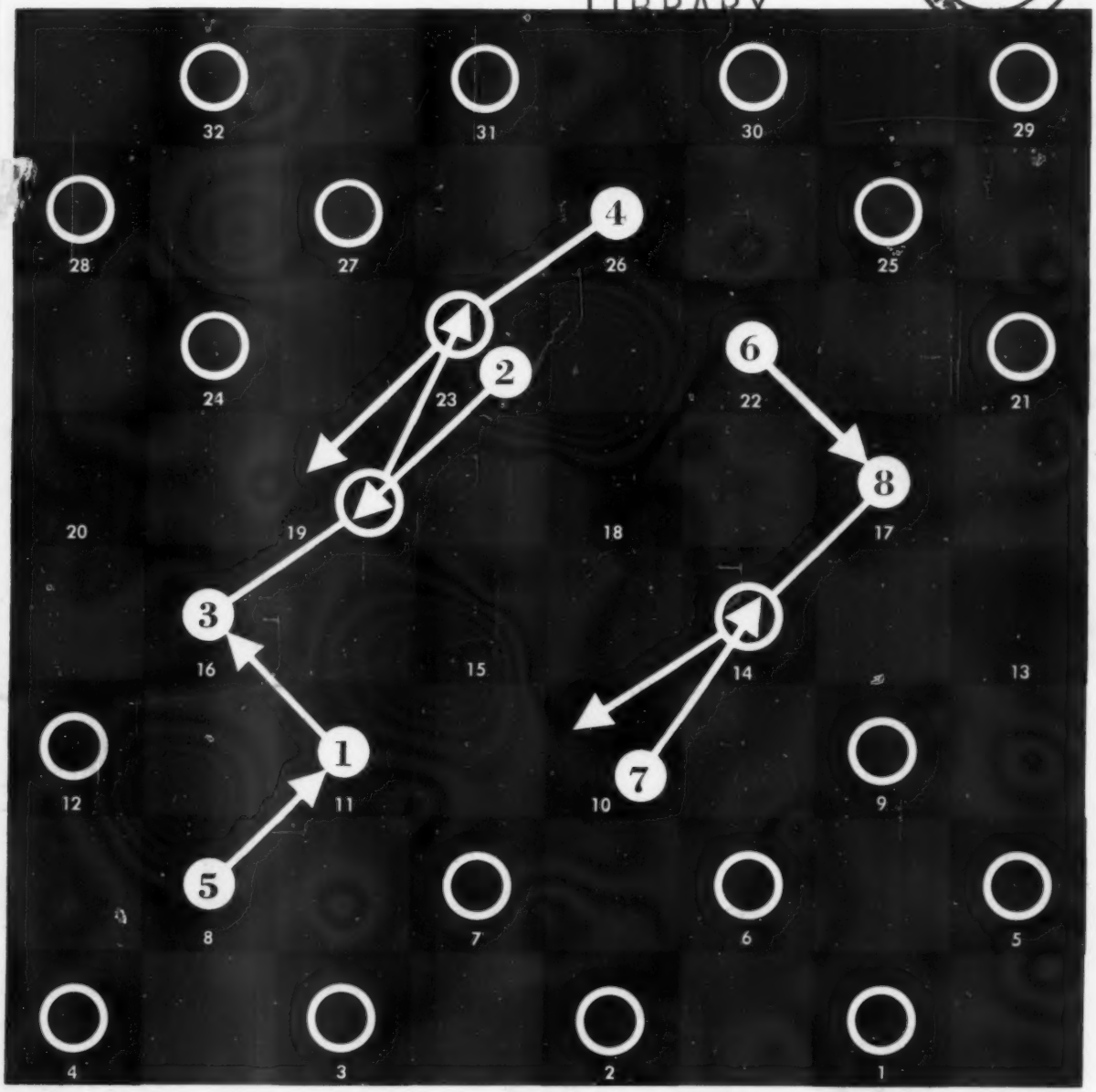
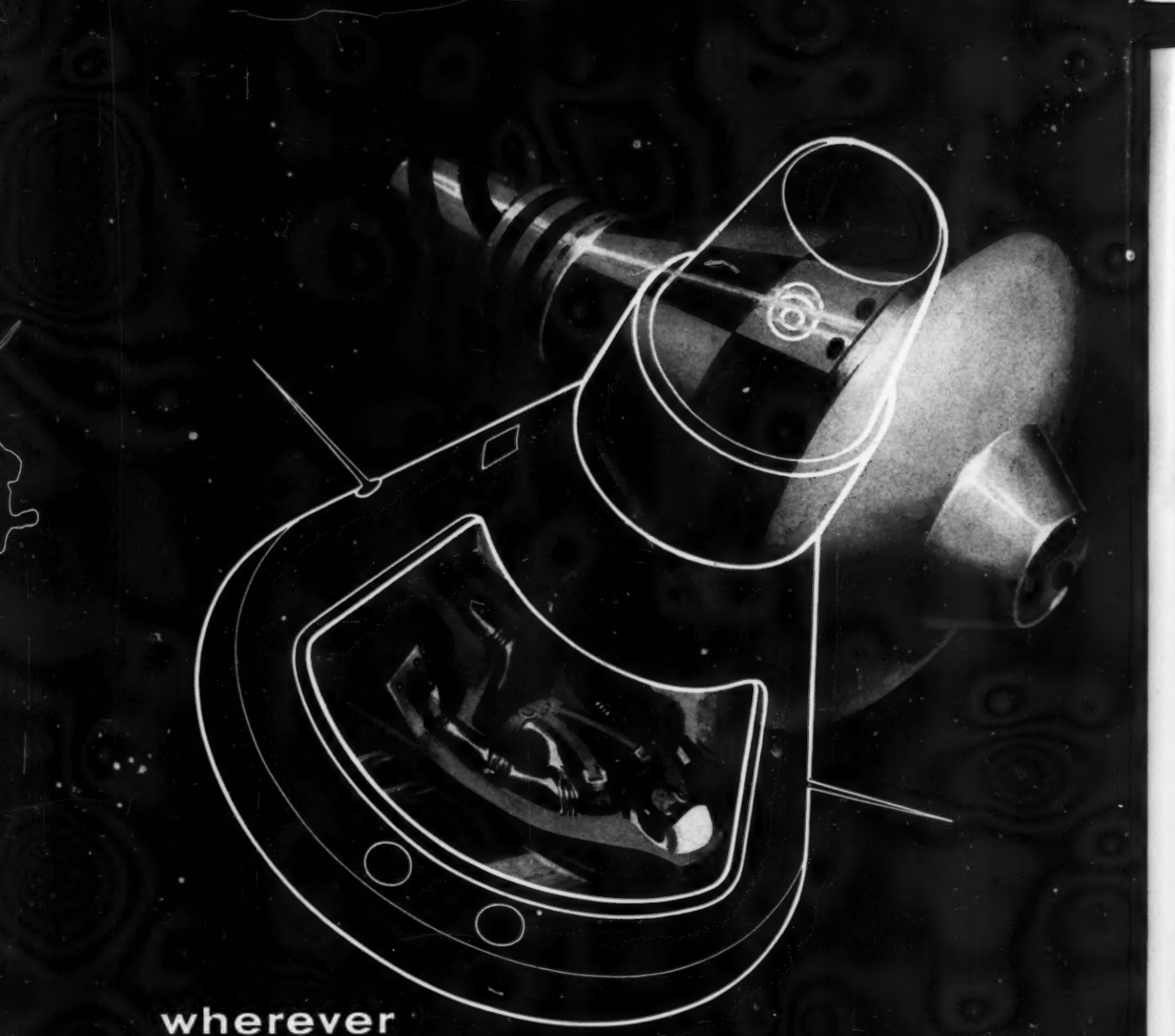


Machine Learning, page 42

Athletics at M.I.T., page 30

NOVEMBER 1959



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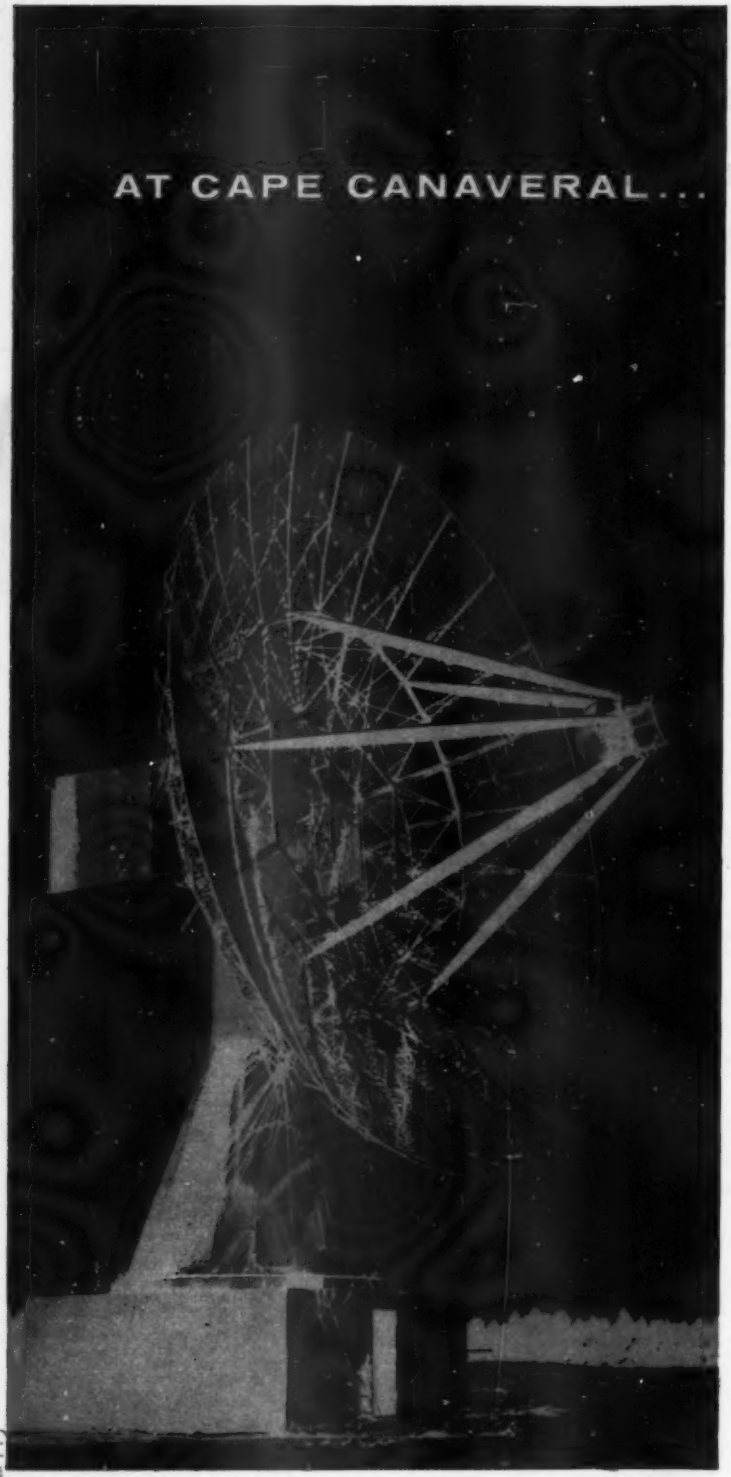

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Important news about the first books to come out of the Physical Science Study Committee

THE SCIENCE STUDY SERIES

During the past three years the Physical Science Study Committee, a group formed at M.I.T., has been working on a program of fundamental importance: to reshape the teaching of physics in secondary schools in the United States.

One vital part of this work has been the commissioning of distinguished scientists to write books which will explain the essence and satisfactions of their work to searching minds of all ages. The first five Science Study Series books, in soft covers and designed for wide distribution and sale at popular prices, are now being published by Doubleday Anchor Books.

During the coming year, at least fifteen of these cogent, readable, illustrated books will be made available. Ultimately, the Science Study Series will comprise more than seventy paper-back volumes. They will range over the key topics of modern physics and geophysics. They will highlight the relationships between the physical sciences and the life sciences. They will revive the most stirring eras in scientific history and the lives of the great scientists. Although an occasional classic will be included in the Series, most of the titles are being especially written to meet the vast and ever-growing needs of an American public whose future may well depend on its scientific awareness.

In addition to the books listed elsewhere in this advertisement, future volumes are now being prepared by such eminent scientists and authors as I. Bernard Cohen, Rene Dubos, Freeman J. Dyson, Laura Fermi, Donald G. Fink, William A. Fowler, Alan Holden, Bernard Jaffe, Alexander Kolin, Philip Morrison, Robert M. Page, Bruno Rossi, Victor F. Weisskopf, Jerome B. Wiesner, and Robert R. Wilson.

"There just weren't any such books when I was a high school student. How lucky those who want to learn about science will be to have them. These books are written by men who know first-hand what is important and what isn't, what is known and what still is not understood, what can be validly explained in simple terms and what can't. And, through the facts and explanations glows a true and real background of science and scientists which no non-participant could provide . . ."—JOHN R. PIERCE, Director of Research, Communications Principles, Bell Telephone Laboratories.

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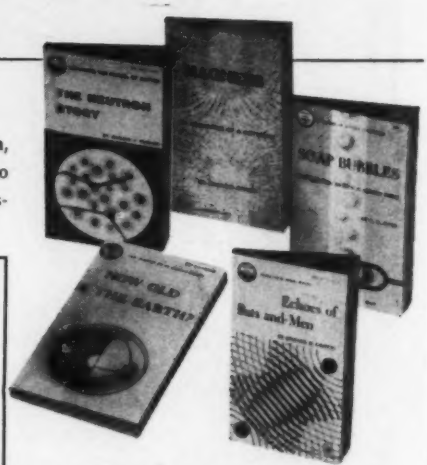

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Forthcoming titles available early in 1960 include:

The Physics of Television • Galileo • Crystals and Crystal Growing • Radio Astronomy • The Birth of a New Physics • Waves and the Ear

The Science Study Series is available wherever Anchor Books are sold, and is distributed to high school students and teachers by Wesleyan University Press, Columbus, Ohio.

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Technology Review

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Volume 62, Number 1 *Edited at the Massachusetts Institute of Technology* *November, 1959*

Feedback

On Solar Sailing

FROM T. C. TSU, 2-44:
In the May, 1959, issue of The Technology Review, Professor Sutton stated that "solar sailing is applicable only in the general direction away from the sun." This statement is misleading and does not do justice to the solar sail.

Professor Sutton's statement is correct only if the sail surface is black and nonreflecting. If the surface is reflecting, then the sail could be so oriented that the force acting on it would have a component either in the direction of motion of the sailing ship or opposed to it. In the former case the force would increase the energy of the ship, causing it to move away from the sun. In the latter case the force would decrease the energy of the ship, causing it to move toward the sun. The latter case is analogous to that of an artificial earth satellite falling back to earth when its energy is depleted sufficiently.

For further details and quantitative relations, please refer to the writer's paper on "Interplanetary Travel by Solar Sail" in the June, 1959, issue of the *ARS Journal*, page 422.

Research Laboratories
Westinghouse Electric Corporation
Pittsburgh 35, Pa.

FROM G. P. SUTTON:
Photons coming from the sun always go in a general direction away from the sun. The forces that can be obtained on a solar sail are therefore always exerted in a direction generally away from the sun. It is correct that by inclining the surface of the sail it is possible to obtain components in other directions but the net total force will never be in a direction toward the sun. The sentence on solar sailing in the article in the May issue of The Review should be interpreted to mean that forces from solar sails can only be obtained in a direction generally away from the sun (plus or minus approximately 70 degrees).

If there is a lot of time available and if you apply these forces at the proper time during a space trajectory, it is possible to alter the trajectory so that the vehicle unit could eventually come closer to the sun.

I appreciate Mr. Tsu's comments.

Advanced Research Projects Agency
Washington 25, D.C.

This Month — *The Cover*

The numbers on the checkerboard show the system used to designate squares, and trace opening moves in a game played against an IBM 704 computer. The method of playing checkers with a computer is explained in the article on page 42.

Individuals Noteworthy **4**

Appointments, deaths, promotions, honors, and other news of M.I.T. people.

Trend of Affairs **17**

Progress and changes on many different fronts at the Institute.

Books **38**

Reviews of nontechnical works of especial interest to Alumni.

Talk of Our Times **48**

Remarks on atomic power abroad by Robert E. Wilson.

Institute Yesteryears **76**

Items that were news 99, 75, 50, and 25 years ago at M.I.T.

EDITOR: Volta Torrey; BUSINESS MANAGER: R. T. Jope; CIRCULATION MANAGER: D. P. Severance; EDITORIAL ASSOCIATES: J. J. Rowlands, Francis E. Wylie, John I. Mattill; EDITORIAL STAFF: Ruth King, Diana de Filippi; BUSINESS STAFF: Madeline R. McCormick, Louise E. Ryan; PUBLISHER: H. E. Lobdell.

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Entered as second-class matter December 23, 1949, at the Post Office, at Bristol, Conn., under the Act of March 3, 1879. Accepted for mailing at special postage rates provided for in Section 538, P. L. & R. Act of February 28, 1925.

David Flett du Pont **26**

His bequest of $1,000,000 made the Institute's newest building possible. It gives the university adequate athletic facilities for the first time. His mother, Dr. Killian, President Stratton, and Richard E. Kaplan, spoke at dedication ceremonies.

The Du Pont Building **28**

This new hub of athletics was designed for participants rather than for spectators of athletic events. It connects three older buildings, has a new kind of foundation, and will facilitate the use of the Institute's playing fields as well as indoor gymnasiums.

The Role of Athletics **30**

Richard L. Balch, Director of Athletics, explains the objectives and accomplishments of the Athletic Department in a university polarized around science and engineering.

The Athletic Coaches' Review **33**

A series of short reports on the last season by coaches of the many different sports in which undergraduates at M.I.T. now participate.

Recollections of a Scientist **35**

Extracts from a new book, *Magnets*, by Francis Bitter, Professor of Physics and Associate Dean of the M.I.T. School of Science, in which he recalls incidents from his childhood and schooling.

As the World Sees Us **39**

Three pages of photographs which are being distributed overseas by the U.S.I.A. to depict the life of an undergraduate at the Institute.

Machine Learning **42**

A. L. Samuel, '25, reports progress in teaching a computer to play better and better checkers, and explains the techniques employed, which may be applicable to real-life problems.

Alumni Officers Confer **46**

A report on conferences in Chicago and Cambridge at which President Stratton spoke and eight bronze beaver citations were awarded.

Individuals Noteworthy

Floe Is Vice-president

CARL F. FLOE, '35, (above) Administrative Vice Chancellor since 1956, has become Vice-president, Research Administration, for M.I.T. Dr. Floe now has general jurisdiction over the Division of Sponsored Research. He works closely both with Paul V. Cusick, Comptroller, in determining and supervising administrative policies of sponsored research, and also with the Deans of the several Schools to make certain the sponsored research contributes importantly to the educational aims of the Institute.

Dr. Floe has been a member of the Faculty since 1935. In addition to his teaching duties as Professor of Metallurgy, he has held various administrative posts, including that of Assistant Provost.

B. E. Proctor: 1901-1959

THE Head of the Department of Food Technology at M.I.T., Professor Bernard E. Proctor, '23, died in his office in the Dorrance Building on September 24. He had served the Institute since 1925, had pioneered in many kinds of research including most recently the sterilization of food by radiation, and had given much time to public service as a consultant on food problems.

Professor Proctor was born in Malden, Mass., on May 5, 1901. He was salutatorian of his class in the Malden High School, and received both his bachelor's and doctor's degrees from M.I.T. For three years he was an instructor in biochemistry at Boston University School of Medicine. He then joined the M.I.T. staff as an instructor in biology and public health, and became professor of food technology in 1944, director of the Samuel Cate Prescott Laboratories in 1945, and head of the department in 1952.

During World War II, Professor Proctor was expert consultant on foods to the Secretary of War and director of Subsistence and Packaging Research and Development for the Office of Quartermaster General. He also served on a number of National Research Council committees and as a consultant to the U. S. Public Health Service. He had been president of the Institute of Food Technologists and chairman of the Food and Nutrition Section of the American Public Health Association, and was a member of the U. S. delegation to the United Nations Conference on Peaceful Uses of Atomic Energy in 1955. The Appert Medal, highest honor in the field of food technology, was given to him.

Professor Proctor made his home at 100 Memorial Drive, Cambridge. He is survived by his wife, the former Miriam Patten of Andover, Mass.

A. L. Townsend: 1892-1959

LAST August 17, Arthur L. Townsend, '13, died after 40 years' service as a member of the Department of Mechanical Engineering at M.I.T. He was vice-president of the Alumni Association in 1937-1939, and since 1944 had been the director of the Lowell Institute School.

Born in Boston in 1892, Professor Townsend came to M.I.T. from the Boston English High School. When graduated, he joined the Globe Indemnity Company as engineering inspector and soon became New England inspector and chief engineer for the Massachusetts Bonding and Insurance Company. He returned to the Institute as an instructor in 1919, became assistant professor in 1929, and associate professor in 1937. His teaching was in machine design, applied mechanics, and patent relations. He also served for many years as undergraduate and alumni placement officer for the Mechanical Engineering Department.

Professor Townsend was a former chairman of the mechanical engineering division of the American Society for Engineering Education, and received that society's $500 James H. McGraw Award in 1957 for his work as Director of the Lowell Institute School.

W. R. Maclaurin: 1907-1959

W. RUPERT MACLAURIN, Professor of Economics at M.I.T., who was largely responsible for the establishment of his Department's Industrial Relations Section, died on August 17. He was the son of Richard C. Maclaurin, the sixth President of the Institute, and had been on the Faculty since 1936.

Professor Maclaurin was born in New Zealand in 1907. After finishing his course in Harvard College in 1929, he attended the Graduate School of Business Administration and received his M.B.A. in 1932 and the D.C.S. in 1936. He was at Trinity College, Cambridge, England, for a year as a Fiske Scholar in Economics from Harvard, and in Australia for a year as Sheldon Traveling Fellow in Economics. He became an assistant professor at M.I.T. in 1936, associate professor in 1940, and professor in 1942.

He was the author of *Economic Planning in Australia, The Movement of Factory Workers* (in collaboration with Professor Charles A. Myers), and *Invention and Innovation in the Radio Industry*. He helped to strengthen the Department of Economics and Social Science at M.I.T., and was the first director of its Industrial Relations Section.

Survivors include his wife, Elfriede Carter Maclaurin, and four children, Katharine, Robert, Joan, and Nancy. His brother, R. Colin Maclaurin, died last May 4.

(Continued on page 6)

and auxiliary equipment

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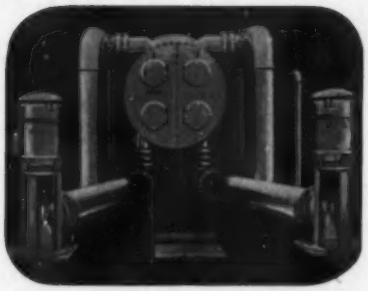

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improves power generating efficiencies...

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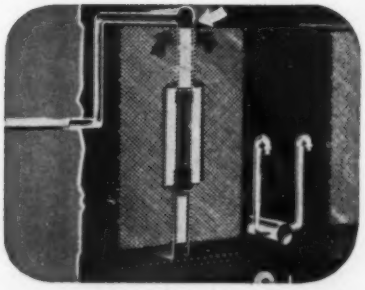
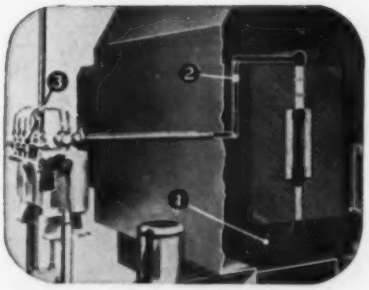


Location of air-vapor takeoff speeds steam travel and allows steam to penetrate to the peripheries of all tubes. It thus improves condenser efficiencies and overall power station operation as well.



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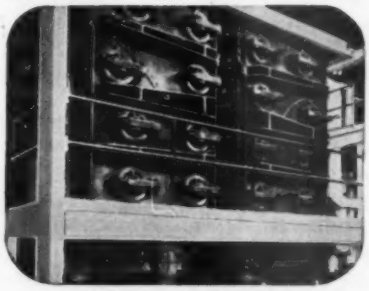

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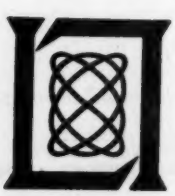


Individuals Noteworthy

(Continued from page 4)

Appointed to the Faculty

RECENTLY appointed associate professors on the M.I.T. Faculty are:

Warren G. Bennis, '53, in the School of Industrial Management, who received his doctorate at M.I.T. in 1955 and has since taught at Boston and Harvard Universities.

Lincoln P. Bloomfield, in the Department of Economics and Social Science, who has served as special assistant to the Assistant Secretary of State for International Organization Affairs and director of the United Nations Project at the M.I.T. Center for International Studies.

William F. Schreiber, in the Department of Electrical Engineering, who received his B.S. and M.S. degrees from Columbia University and Ph.D. from Harvard, and since 1953 has been a research physicist for the Technicolor Corporation.

Assistant professors recently appointed and the departments in which they will teach are:

Ali S. Argon, '53, Mechanical Engineering.

Pierre J. Brosens, '55, Mechanical Engineering.

Alfred R. Cooper, Jr., Metallurgy.

Paul H. Cootner, '53, School of Industrial Management.

Robert G. Dean, Civil Engineering.

Robert Evans, Jr., '54, Economics and Social Science.

James W. Graham, '52, Electrical Engineering.

Alan L. McWhorter, '55, Electrical Engineering.

Ronald Melzack, Economics and Social Science.

John R. Myer, '52, School of Architecture and Planning.

Gordon C. Oates, Aeronautics and Astronautics.

Ronald E. Rosensweig, Chemical Engineering.

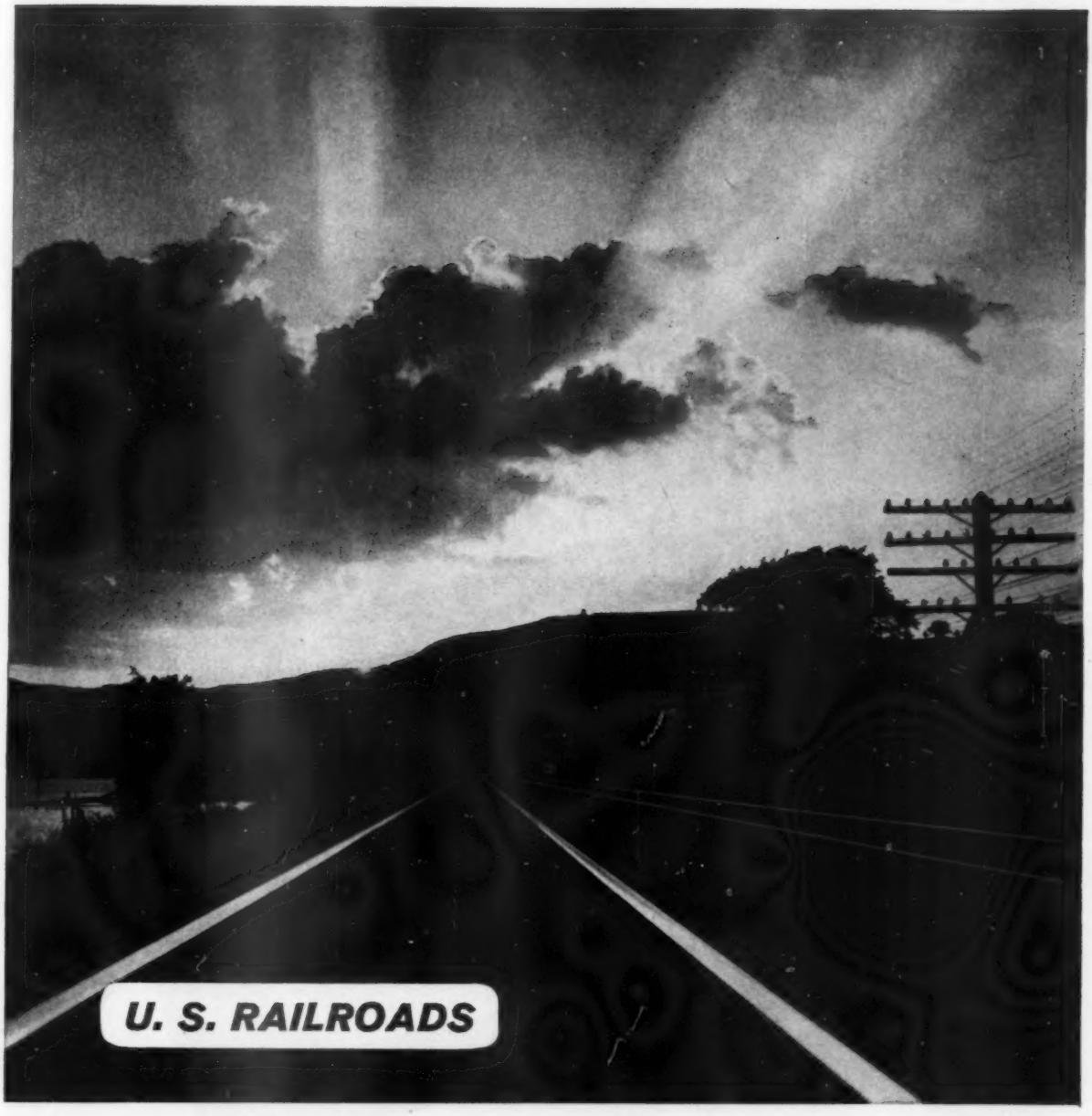
Abner E. Shimony, Humanities.

Yehuda Stavsky, Civil Engineering.

Egons Tons, '54, Civil Engineering.

Michael A. Wallach, Economics and Social Science.

(Continued on page 10)



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Individuals Noteworthy

(Continued from page 6)

Honors to Alumni

SPECIAL awards to Alumni reported since last July included:

To *Francis V. du Pont, '17,* citation as Delaware's Engineer of the Year, by the Delaware Society of Professional Engineers . . . to *George C. Manning, '20,* the Distinguished Service Medal, by the Minister of Navy of Brazil . . . to *Major General Alfred B. Quinton, Jr., '21,* an honorary doctorate of laws, by Washburn University;

To *Harold E. Edgerton, '27,* the George W. Harris Award, by Professional Photographers of America, Inc. . . . to *David R. Tashjian, '34,* an honorary doctorate of science, by Western Michigan University . . . to *John H. Hollomon, '40,* the grade of fellow, by the Academy of Arts and Sciences;

To *James B. Weaver, 2d, '44,* the Award of Merit for 1959, by the American Association of Cost Engineers . . . to *Arthur E. Francis, '48,* an honorary doctorate of engineering, by Stevens Institute of Technology . . . to *Jack H. Westbrook, '49,* the Richard L. Templin Award, by the American Society for Testing Materials.

(Continued on page 62)

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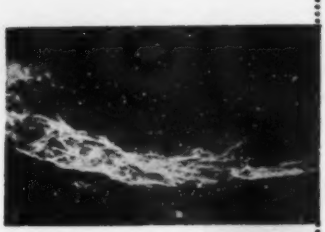

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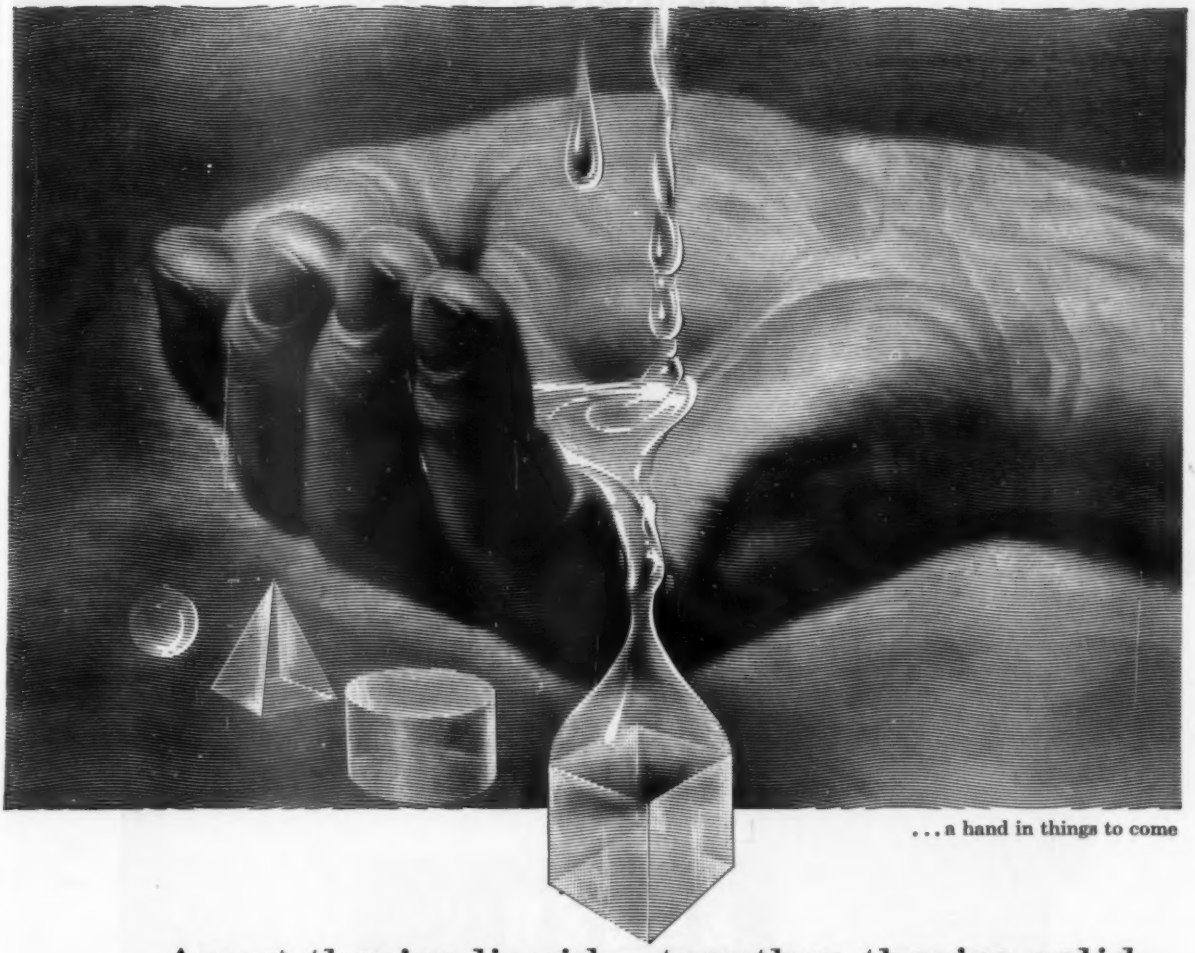

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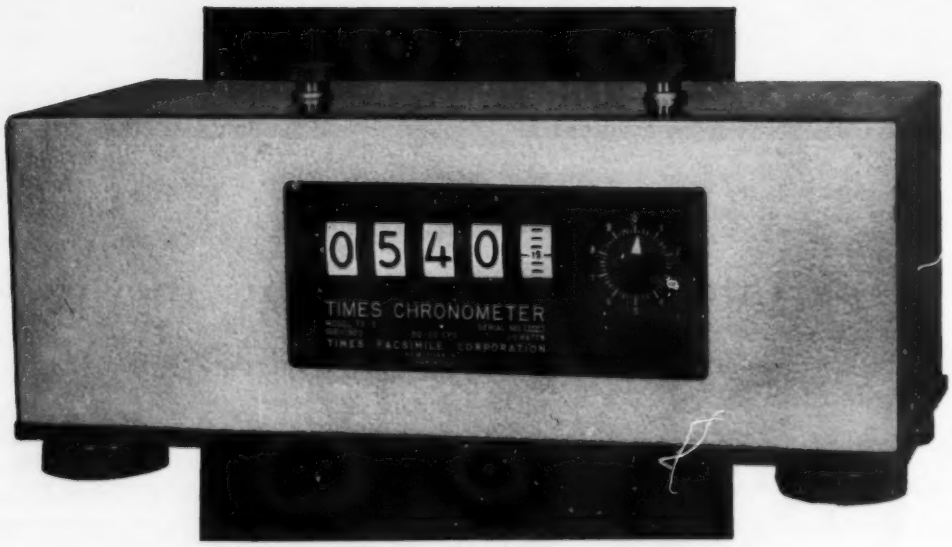

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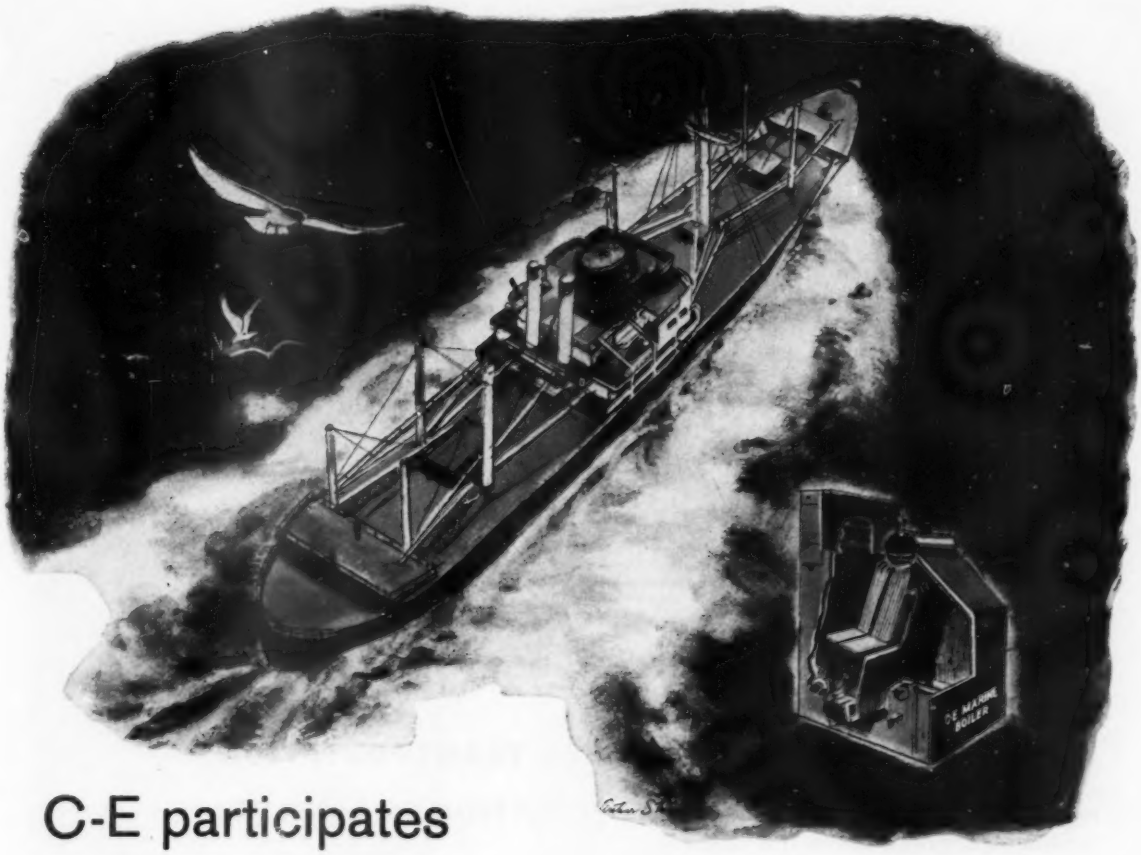

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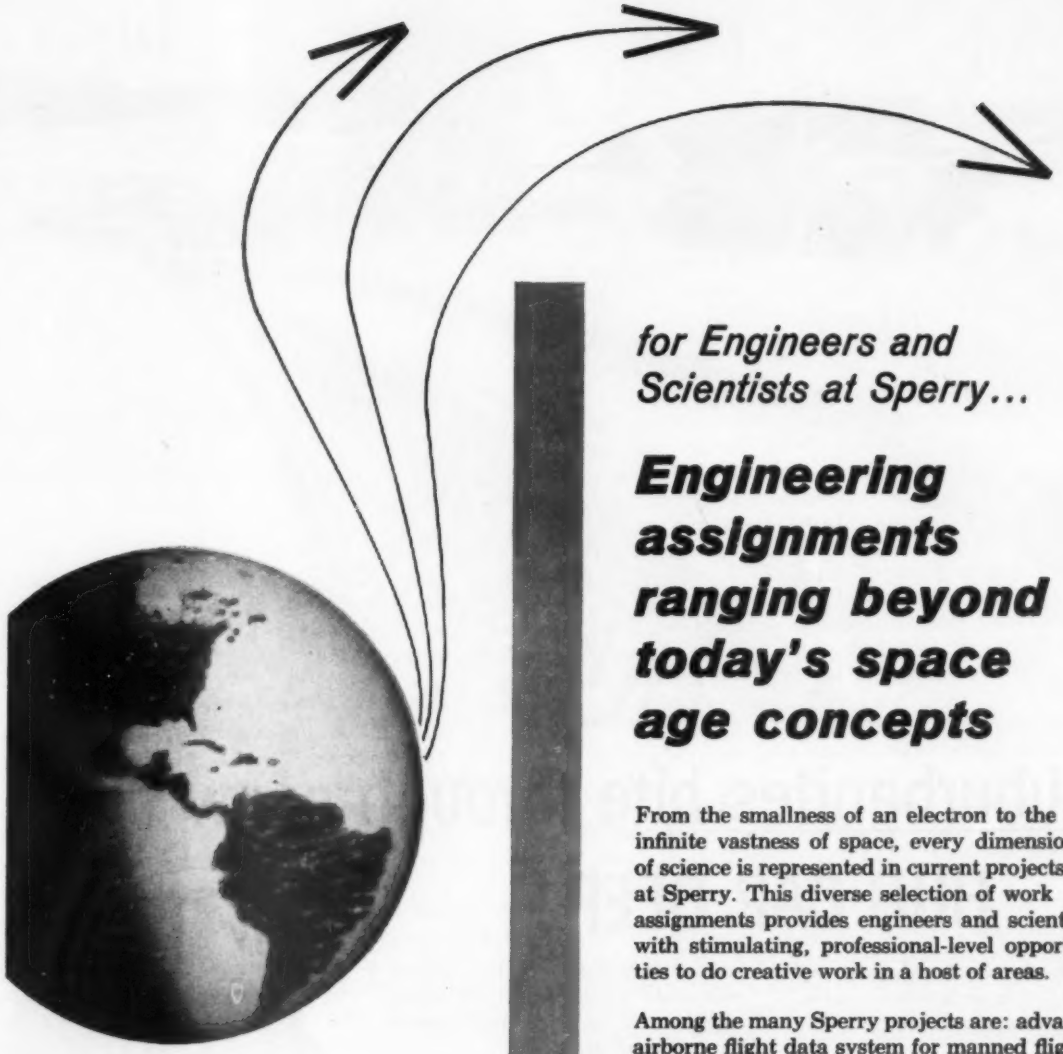

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Trend Of Affairs

President Foresees More Interdisciplinary Centers

IN HIS annual report as President of M.I.T. last month, Julius A. Stratton, '23, warned that in the future the Institute and comparable institutions "may be compelled to break with conventions of the past" in order "to teach difficult, basic subjects to larger groups of students."

A rather free-and-easy epoch in American history has ended, in Dr. Stratton's opinion, and one has arrived in which we must rely more on the quality of our goods and services than on their bulk. The Institute, he believes, can more effectively serve the national interest by improving the quality of the education that it offers than by yielding to the pressure to admit more students.

Bold and creative thinking is needed about both the substance and the methods of instruction, the President argues, because three major forces "are working to make obsolete large segments of the traditional curricula and to outmode many of the methods of instruction." These are: (1) the stupendous accumulation of new knowledge and principles flowing from advances in every field of science and engineering; (2) the increasing importance of a thorough command of modern physics, chemistry, and mathematics; and (3) the rapid dissolution of the traditional boundaries between professional fields which has required that the foundations of a sound professional education constantly be broadened.

"Within a decade," Dr. Stratton notes, "we have seen the advent of a multitude of new fields, effectively non-existent at the outset of the second World War and now of crucial importance to both science and industry.

"No educational institution can remain aloof from all these developments and keep pace with the leaders. But each new venture into a new area brings with it new faculty, new laboratories, and new students. The influence is felt first at the graduate level, but rapidly penetrates to the domain of the undergraduate, bringing new material into the curricula and affecting many aspects of instruction. There is no greater popular misapprehension about the nature of science than that it is built upon a fixed and permanent structure."

To illustrate the pressures, Dr. Stratton cites the increasing enrollment for mathematics work at M.I.T., and the difficulty of maintaining the quality of instruction which ensues. "We should re-examine with an open mind," he believes, "the relative merits of the lecture, recitation, tutorial, and seminar methods, and we should be progressive in the use of every modern technique for the effective presentation of subject matter in classroom and laboratory."

He foresees development of more interdisciplinary groupings for teaching and research similar to the Research Laboratory of Electronics, the Laboratory for Nuclear Science and the Center for Internationl Studies, and notes that "the most comprehensive of these plans encompasses the field of materials.

"It is a field," the report continues, "in which M.I.T. occupies a unique position. In no other academic institution is there so large and so strong a group in solid state science and materials engineering. Nearly 100 faculty members are active in the field. In all, over 500 people drawn from nine different departments, including graduate students, are participating in this work. Our annual budget for research in materials is now in excess of $4,000,000. The strength of M.I.T.'s program arises not merely from its size but from its distinction and from the wide span of its interests – ranging from the most theoretical studies to work of immediate engineering significance. Our plan is to draw these diverse efforts into a large and integrated laboratory which will facilitate co-operation between the scientific and engineering departments, both in research and in the education of students."

In such centers, Dr. Stratton believes, "we are beginning to see something of the future organization of a modern scientific university . . . Initially, these laboratories were conceived principally as centers of graduate and postdoctoral research. It is now quite apparent that because of their size, the availability of equipment, and the character of their financial support, they also afford to M.I.T. our most challenging opportunity to introduce students to the problems and spirit of research in their undergraduate years."

In 1958-1959, the report concludes, the Institute's academic expenses were $23,125,000, which was about 10.6 per cent more than in the preceding year. Sponsored research represented an expenditure of $59,627,000, an increase of nearly 10 per cent. The Institute's investments had a book value of $97,865,000, and a market value of $155,777,000 as of June 30, 1959.

M.I.T. Seeks Basic Knowledge About Very, Very Hot Stuff

THE National Science Foundation further fortified Cambridge's position on the scientific frontiers this fall by granting $500,000 to M.I.T. and $300,000 to Harvard University for the study of ionized gases.

Oceans of such plasmas lay in the atmosphere, affect communication over long distances, and must be penetrated when ballistic missiles and space travelers return to earth. Plasmas also account for the radiation from stars, the aurora borealis, and even the neon lights on Main Street. There is hope now of controlling reactions in which naked atomic nuclei are fused together, and thus making fabulous amounts of energy available; efforts to do this, however, have been handicapped by men's meager knowledge of the behavior of plasmas in magnetic fields. More knowledge also is needed to design space-propulsion systems.

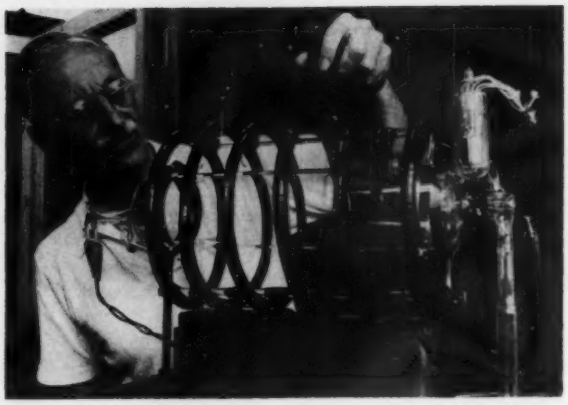
Plasmas have been studied at M.I.T. since World War II; they were employed in devices on which work was done in the Radiation Laboratory to switch radar equipment quickly from transmitting to receiving apparatus. Interest in electrical plasmas has risen rapidly ever since. Plasmas similar to those in the upper atmosphere have been produced in laboratory devices. Magnetic bottles to hold plasmas have been built. As more has been learned about these extremely hot gases, and done with them, uses for them in a tremendous variety of human activities and ambitions have been envisioned.

"It is," says William P. Allis, '23, Professor of Physics, "as if people had lived all their lives in the mountains and then had come down to the edge of the oceans. Before they could use sea water or navigate through it, they would have to learn some things that would be perfectly obvious to anyone who had lived by the ocean. We are dealing with an unknown sea of gas and we have a great deal to learn."

Both the United States and Russia have sunk vast sums into construction of big devices in which it was hoped thermonuclear reactions might be confined and utilized for peaceful purposes. These have increased our awareness of the problem's complexities without solving it. No such gigantic experimental devices are contemplated in Cambridge until more fundamental knowledge has been acquired.

The need for a larger inventory of basic knowledge has been long appreciated at M.I.T. A $250,000 research program (part of the larger effort known as Project Sherwood) for the Atomic Energy Commission has been under way in the Research Laboratory of Electronics for about three years. Several other research contracts are also related to the study of plasmas. These include a $100,000 Joint Service contract for work in electronics, a $100,000 Wright Aeronautical Center contract for research in energy conversion, and a $25,000 Cambridge Air Force Research Center contract for the study of high-energy shock waves. Research of this kind will be considerably extended with the National Science Foundation grant.

At M.I.T. it will be called the Plasma Dynamics Program and headed by Professor Allis. On the committee in charge of it with him are Professor Jerome



Professor Allis shows how plasma is influenced by a magnet.

B. Wiesner, Director of the Research Laboratory of Electronics; Professor Ascher H. Shapiro, '38, and Associate Professors Sanborn C. Brown, '44, and David J. Rose, '50. Representatives of several departments will work together on this program.

Harvard will have a High Temperature Gas Dynamics Project, and its principal investigator will be Howard W. Emmons, Gordon McKay Professor of Mechanical Engineering.

Each school will have its own program, but the staffs will exchange information about their activities. About 100 persons will be employed on the two projects.

Even though combustion has long been used, and lies at the very base of technology, Professor Emmons contends that our understanding of the process is meager, and expects it to be increased by these programs. "The study of mechanical phenomena has led to many mechanical engineering applications, and the study of electrical phenomena has led similarly to enormously important electrical engineering applications in our complex society," he has pointed out. "The proposed work attempts to understand better some of the phenomena wherein both mechanical flow and electrical effects are important. It requires only reasonable optimism to hope for useful results."

Regular readers of The Review will recall the role of ionized gases in the advanced space-propulsion systems which George P. Sutton described in the May issue; the difficulties resulting from ionization of gas when a missile or space ship re-enters the atmosphere have been well ballyhooed in the nation's press. In addition to work pertinent to such matters, and the controlled thermonuclear fusion problem, the M.I.T. program will include research on electrical plasma as a factor in communications. Radio waves now are bounced off the ionosphere in some transmissions, and must go through the ionosphere to reach spacecraft and other planets. Another section of the M.I.T. research will deal with the production of plasma by microwaves, and the microwaves which plasmas emit. Still another will involve study of the plasma that is produced in carbon arcs operated in high vacuums.

At Harvard, simultaneously, answers to questions about sunspots, solar flares, and prominences will be sought, as well as to questions about possible entry into the atmospheres of various planets.

Johnson Succeeds Brooks in Industrial Management School

SINCE the School of Industrial Management was established at M.I.T., its Dean has been E. P. Brooks, '17, who returned to the Institute to head this school, recruit its staff, and develop its program, after a successful career in industry. This summer Dean Brooks asked to be relieved of his administrative responsibilities so that he might devote his full time to special studies of interest to the school, and on November 1 he was succeeded as Dean by Professor Howard W. Johnson, who for the last year has been Associate Dean.

Professor Johnson came to M.I.T. in 1955 to direct the Sloan Fellowship Program for young executives from business and industry. The next year he organized the Program for Senior Executives, which now brings a group of top-level men to the Institute each year. Both of these programs were made possible by the Alfred P. Sloan Foundation, which also was responsible for founding the School of Industrial Management.

Professor Johnson, who is now 37, studied economics at Central College in Chicago, the University of Chicago, and the University of Glasgow, Scotland. He was on the faculty of the University of Chicago for seven years, and was formerly assistant to the vice-president of personnel administration for General Mills, and a member of the staff of Robert N. McMurry & Company, management consultants, in Chicago. He served in the Army during World War II and at its end was deputy civil affairs representative for the city of Montpelier, France.

Dean Brooks has been a term member of the M.I.T. Corporation, vice-president of Sears, Roebuck and Company, and a director of that and six other companies. Last year he was awarded the honorary degree of doctor of science in commerce by the Drexel Institute of Technology.

"M.I.T. is very much in his debt," President Stratton said in announcing his retirement as Dean, "and we are delighted that he will continue to be associated with the school as dean emeritus and professor."

The Class of 1963

ON ITS first Saturday night in Cambridge, the Class of 1963 heard Institute Professor Norbert Wiener lecture on "Analysis of Brain Waves." The Kresge Auditorium was nearly filled. Earlier, the class met President Julius A. Stratton, '23, Dean John T. Rule, '21, and Professor Roland B. Greeley, chairman of the Freshman Advisory Council; and heard Deans George R. Harrison and Gordon S. Brown, '31, Visiting Institute Professor Edwin H. Land, and Professor Charles S. Draper, '26, lecture on subjects that many of their parents would find brand new.

These 941 freshmen came from 600 secondary schools, where four-fifths were in the top 10th of their class. Thirty were from foreign countries; and the class included 21 women, a record number.

Dean Howard W. Johnson (left) of the School of Industrial Management, with his predecessor, Dean Emeritus E. P. Brooks, '17.

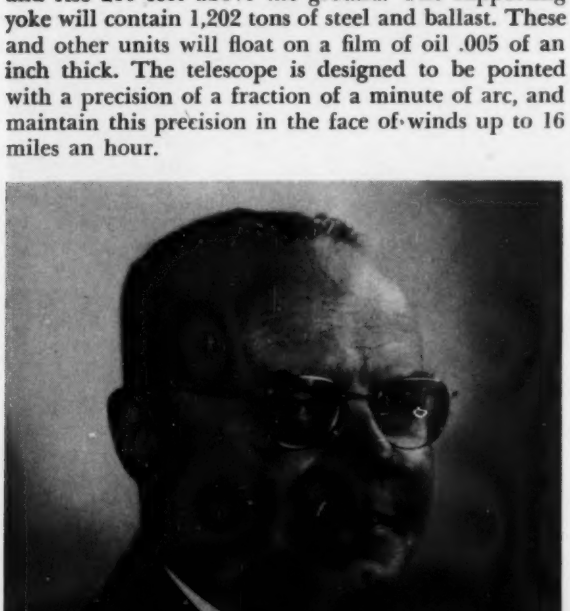
Radio Observatory's Head Gives Compton Lectures on Universe

A SERIES of six Karl Taylor Compton lectures on "The Universe" will be given at M.I.T. this month by Otto Struve, Director of the new National Radio Astronomy Observatory at Greĕn Bank, W.Va. Dr. Struve (pronounced Stroo-veh) is the author of about a thousand papers on problems of stellar physics and other aspects of astrophysics. His interests have spanned many astronomical specialties, and his fame both as an observer of the stars and theoretician is world-wide.

The National Radio Astronomy Observatory which he now heads was established only three years ago. It is operated for the National Science Foundation by Associated Universities, Inc., an educational corporation sponsored by M.I.T. and eight other universities, which also operates the Brookhaven National Laboratory on Long Island.

This observatory was designed to advance the study of the universe with new instruments. It already has erected an 85-foot radio telescope for the use of American astronomers and has a second, large precision telescope under construction now at Green Bank.

When completed in the summer of 1960, this 140-foot telescope, in which about $5,000,000 is being invested, is expected to pick up radio waves transmitted from objects far beyond the range of optical telescopes. The equatorially mounted "bowl" or "dish" with which the sky will be scanned will weigh 350 tons and rise 210 feet above the ground. The supporting yoke will contain 1,202 tons of steel and ballast. These and other units will float on a film of oil .005 of an inch thick. The telescope is designed to be pointed with a precision of a fraction of a minute of arc, and maintain this precision in the face of winds up to 16 miles an hour.



Otto Struve, who will give the Compton lectures this year

This 85-foot radio telescope has been in use since last February at the National Radio Observatory.

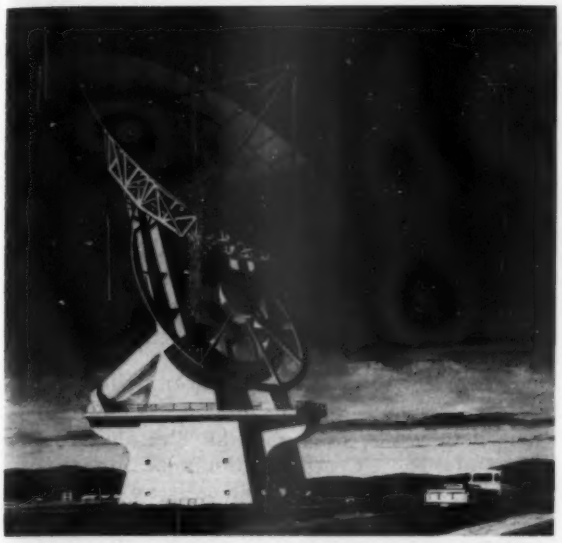
Green Bank was chosen as the site for this precision instrument because of its mild weather, sparse population, and the mountains which effectively shield it from many sources of interference. The U.S. Navy is building an even more gigantic radio telescope in the same vicinity. This one, which is not scheduled to be completed until 1962, will dwarf both the 250-foot dish now in use at Jodrell Bank in England and the 350-foot telescope which the Soviet Union is reported to be planning. The West Virginia legislature has provided for strict control of electrical interference in the area, and the Federal Radio Communications Commission has established a "radio quiet zone" extending for many miles around this new center of astronomical and communication research.

Dr. Struve, who is now 62, left his post as Professor of Astronomy at the University of California to become the new national observatory's first Director last July. His father, grandfather, and great grandfather were astronomers, and he has directed some of this country's greatest astronomical observatories.

The first distinguished astronomer in the Struve family was Friedrich Georg Wilhelm von Struve, who built the Pulkovo Observatory near Leningrad for Czar Nicholas I in 1835 and systematically surveyed the sky for double stars. His son, Otto Wilhelm Struve, succeeded him as Director of this observatory and discovered about 500 double stars. His son, Ludwig Struve, also headed the Pulkovo Observatory and was a dean at the University of Kharkov.

Otto Struve was born in Kharkov and received a diploma of first rank from this university in 1919. He was an artillery officer in the Imperial Russian Army on the Turkish front in 1916-1918 and in the White Russian Army in 1919-1920. He came to the United States in 1921 as a graduate student and assistant in spectroscopy at the Yerkes Observatory of the University of Chicago, and became an American citizen in 1927.

Dr. Struve organized and founded the McDonald Observatory of the University of Texas, and directed



This 140-foot radio telescope is going up now at Green Bank, W.Va. Controls and radio receivers will be in base.

both this and the Yerkes Observatory from 1932 to 1947. Later, at the University of California, he directed the Leuschner Observatory. He is a member of many academies and honorary societies, has received a long list of medals, and has served as President of both the American Astronomical Society and the International Astronomical Union.

He is noted both for his contributions to theories of stellar evolution, and his studies of binary stars, and stars with extended atmosphere. Dr. Struve has been a proponent of the hypothesis that planetary systems are the result of stellar evolution, in contradistinction to theories of collisional or other cataclysmic origin, suggesting that planetary systems such as ours may be exceedingly abundant throughout the universe. He has suggested that life, and even intelligent life, may exist on millions of planets of an enormous number of stars.

His first Compton lecture, at 8:00 P.M. in the Kresge Auditorium on November 3, will be on "The Solar System: Its Origin and Evolution." Dates and topics of the other lectures will be: November 5, "Stellar Evolution"; November 10, "Structure and Evolution of the Galaxy"; November 12, "Radio Astronomy"; November 17, "Binary Stars and Variables"; and November 19, "Man and the Universe." Alumni will be welcome at all of these lectures.

While at M.I.T., Dr. Struve also will participate with distinguished scholars of the Institute and other schools in three seminars. The first, on November 6, will deal with "Nuclear Stellar Evolution"; the second, on November 13, with "Extraterrestrial Life"; and the third, on November 20, with the lively topic, "Cosmological Theories."

The Karl Taylor Compton lectures were planned to honor the Institute's ninth President by dramatizing the combined scientific, cultural, and philosophical concerns emphasized in his 25 years of leadership. The first series of these lectures, given two years ago by Professor Niels Bohr, dealt with "The Philosophical Lesson of Atomic Physics."

90 Umbrellas in Moscow

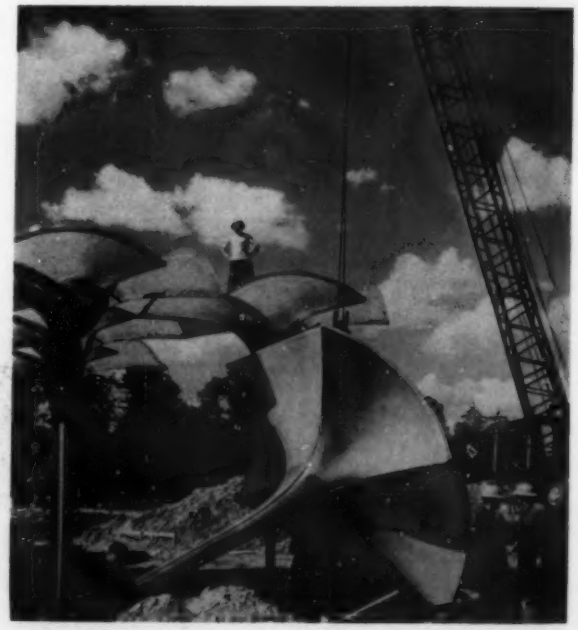
ALBERT G. H. DIETZ, '32, Professor of Building Engineering at M.I.T., was jet-propelled to Moscow last summer to help raise roofs for the American Exhibition. No such roofs had been built in this country. These were for the three pavilions that housed the much-discussed Fashion Show, the "Family of Man" photographic exhibit, and the Architectural Exhibit.

Each roof consisted of a cluster of glass-fiber reinforced plastic umbrellas 20 feet high. The hexagonal tops of these big, man-made flowers permitted them to be fitted together to meet the requirements of the exhibits. Each unit weighed 700 pounds, and was supported by a precast concrete footing. Ninety of these umbrellas were assembled and raised in a week despite rainy weather, language handicaps, and the Russian workmen's unfamiliarity with such materials and forms.

Designed by George Nelson Associates, and approved after intense studies in which Professor Dietz and Assistant Professors Frank J. Heger, Jr., '48, and Frederick J. McGarry, '50, participated, the units were molded in this country by Lunn Laminates, and shipped to Russia via Helsinki. Russian sheet-metal workers put them up under the direction of Jack Parris of the Lydick Roofing Company of Fort Worth, Texas.

The resin was chosen for its fire resistance rather than its durability. To make certain that Moscow breezes would not send ripples through these plastic flowerbeds, a few units were erected beforehand on Long Island and subjected to the gusts from some B-26's.

"The finished canopies," says Professor Dietz, "had a light greenish cast that blended well with the pines and the other trees in Sokolniki Park, and provided the soft, diffused light that the exhibitors wanted."



Plastic "flower gardens" provided the roofing for American exhibits in Moscow. This is the way units were set in place.

Magnetic-Film Computer Memory

A MEMORY is as useful to a modern digital computer as to a person: to carry out even a simple task, a computer must be able to store a great deal of information and recall it as needed. (*See* "Machine Learning," by Arthur L. Samuel, '25, on page 42.) Large capacity, high speed and extreme reliability are important considerations in designing computer memories; physical size, power consumption, cost and simplicity of design and construction are other interrelated factors.

The fastest, most versatile computer memories in general use today store information magnetically in tiny, doughnut-shaped "cores" of ferrite material. These were an important M.I.T. contribution to computer technology, resulting from research and development work at the former Digital Computer Laboratory and at Lincoln Laboratory. Lincoln built the largest such memory ever attempted, with more than 2,500,000 cores; it is now part of the TX-2 computer. Conventional memories of this type have read-and-write cycle times of 5 to 10 microseconds.

As potential successors to ferrite cores, thin films of magnetic materials have been investigated in many laboratories. Magnetic films can be switched faster than cores with appreciably less electrical power; they easily can be driven by transistors instead of vacuum tubes, with greatly increased reliability. Wires can be laid along the top of a row of film elements, eliminating the difficult task of threading three or four wires through the center of each individual core (a hole .05 inch or less in diameter), and this contributes to the possibility that magnetic film memories can be fabricated more simply and packaged more compactly than core memories.

Realization of these potential advantages requires solution of problems of film fabrication, memory packaging, and associated circuitry. Engineers and scientists at Lincoln have solved these problems to the degree necessary to construct a small prototype. This memory, the first magnetic film memory ever installed in a computer, has functioned successfully as part of the TX-2 since July.

It is completely transistor-driven, its current requirements are low, and it is about 10 times as fast as conventional core memories. Each element is a circular spot of Permalloy film .000003-inch thick and $\frac{1}{16}$ inch in diameter. The film spots are 82 per cent nickel and 18 per cent iron. They are deposited by evaporation on a flat glass substrate .005-inch thick, in 16-by-16 unit arrays as shown in the photograph on this page.

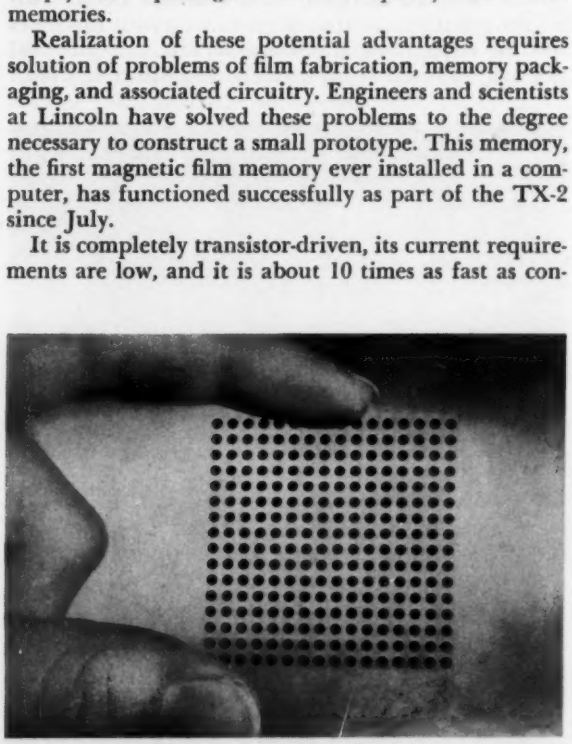
The magnetic-film memory is another milestone in the steady advance of modern computer technology. This memory, and the TX-2 computer of which it is a part, were developed by Lincoln Laboratory under an Air Force contract, with the joint support of the Army, Navy, and Air Force.

News You May Have Missed

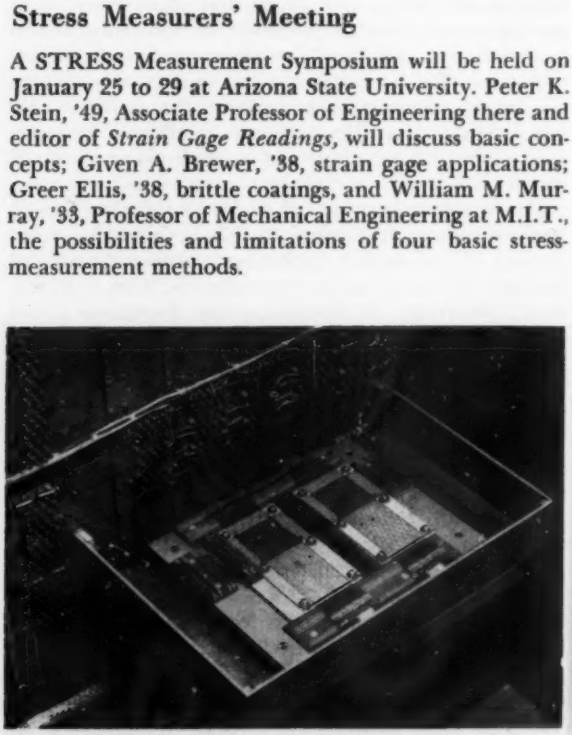
THE Servomechanisms Laboratory at M.I.T. has changed its name: it is now the Electronic Systems Laboratory. . . . A Central Radioisotope Storage Area, to receive, unpack, monitor, and deliver or store radioactive materials sent to M.I.T. has been built in the basement of Building 6. . . . The first international conference ever held in the United States on the use of atomic energy to preserve food was held at M.I.T. last summer: 24 nations were represented. . . . Institute publications won a first-place medal and three citations of merit for the Office of Publications at this year's meeting of the American College Public Relations Association: the citations were given for the Institute's catalogue, the annual report, and student recruitment materials. . . . M.I.T. has received a $10,000 grant from the Rockefeller Foundation for a study of "the politics of outer space" to be directed by Professor Lincoln P. Bloomfield.

Stress Measurers' Meeting

A STRESS Measurement Symposium will be held on January 25 to 29 at Arizona State University. Peter K. Stein, '49, Associate Professor of Engineering there and editor of *Strain Gage Readings*, will discuss basic concepts; Given A. Brewer, '38, strain gage applications; Greer Ellis, '38, brittle coatings, and William M. Murray, '33, Professor of Mechanical Engineering at M.I.T., the possibilities and limitations of four basic stress-measurement methods.



Spots of magnetic film in this memory unit play same role as doughnut-shaped cores now used in many large computers.



This magnetic-film computer memory, developed at Lincoln Laboratory, is driven completely by transistors around edges.

A Schoolhouse Built of Plastic Panels

THE photos on this page are of a model of a plastic schoolhouse. Such a building could be expanded, converted to new uses, or taken apart, moved and reassembled. The model was built at M.I.T., as part of a study of architectural uses of plastic sandwich panels under a grant-in-aid from the Plastics Division of the Monsanto Chemical Company by a staff headed by Marvin E. Goody, '51, Assistant Professor of Architecture.

The load-bearing sandwich panels used in this design have thin outer skins bonded to a core of plastic foam. An eight-foot square panel weighs only about one-tenth as much as a comparable concrete shell. The panels in the exterior walls, like those in the roof, could be Fiberglas reinforced polyester, and varied in color and texture. Many different types of facing are available for interior walls.

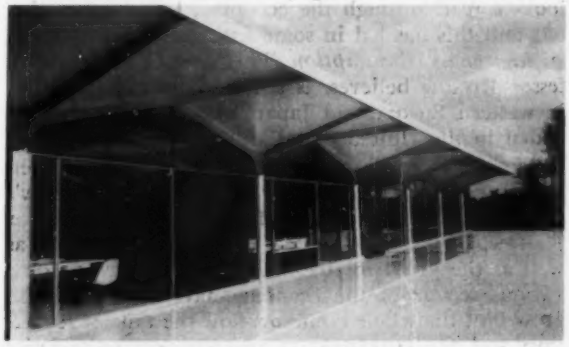
School committees, working with their architects and planners, says Joseph Schiffer, special research assistant and designer, could employ the sandwich-panel concept to obtain a flexible shelter for a variety of educational systems.

"This school," adds Professor Goody, "is a versatile, complete package. To obtain the benefits of flexibility that it offers probably would cost slightly more—at this time. Eventually, as mass production and improved manufacturing techniques lower material costs, a plastic school incorporating the versatility that a regular building cannot offer should be possible at significant savings. We figure, too, that the planning time for a full-scale building can be cut approximately one-third, and the actual construction time can be cut in half."

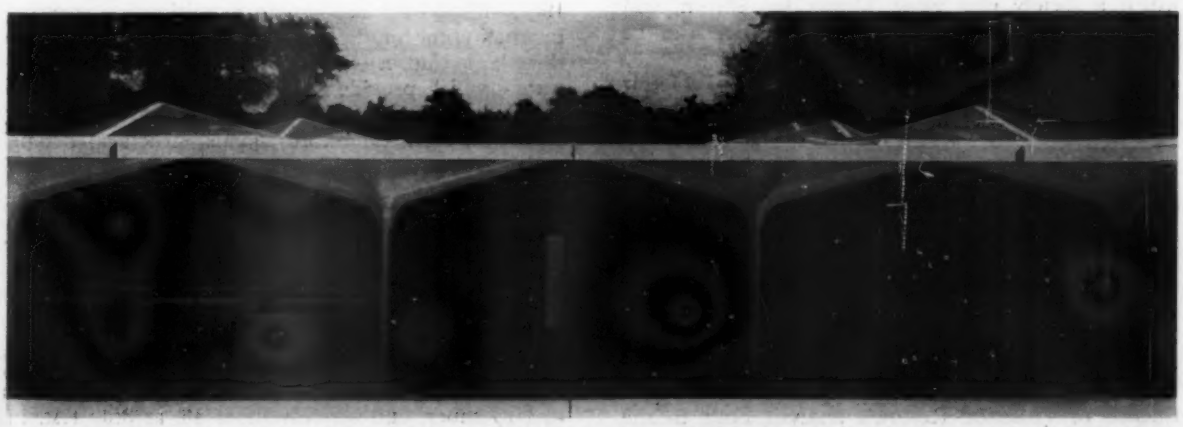
Additional research is needed, however, in some areas. The use of newly developed plastics to decrease sound transmission, and introduction of less expensive chemicals for fire retardancy, for example, are being studied now.

The project staff is from both the Department of Architecture and the Department of Civil and Sanitary Engineering.

Sandwich panels at rear of classroom in plastic school are movable. Translucent skylight is in center of room.



Glass walls admit additional light. Heating or cooling units are installed independently, as the model shows.



Plastic school's roof consists of hyperbolic paraboloid panels supported by central columns. Additional 16-by-16-foot units can be added to school without complications. Drainage is through the columns of these "tree units."

An Answer to Marxism

PROFESSOR WALT W. ROSTOW of M.I.T. delivered a series of lectures at Cambridge University which have been attracting widespread attention since *The Economist* (last August 15 and 22) published a condensation of them and called them one of the most stimulating contributions to political and economic discussion by an academic economist since the war.

Professor Rostow's subject was "The Stages of Growth," and these lectures can well be described as "a non-Communist Manifesto," because in them he presented an alternative to the Marxist interpretation of modern history. Karl Marx saw the stages of growth as feudalism, bourgeois capitalism, socialism, and communism. Professor Rostow sees five other broad categories into which the countries of the world fall, and has traced the growth of many countries through these stages.

The pre-Newtonian world was a world of *traditional* societies, in which production was limited by meager knowledge of science. Then came a *transitional* stage, during which the foundations were laid for changes. The third stage in this view of history is what Professor Rostow calls "the crucial process of *take-off*." Great Britain reached this stage first, the United States was in it from about 1843 to 1860, Japan from 1878 to 1900, and Russia from 1890 to 1914; China and Turkey are regarded as still in this stage.

A *maturing* stage, in which new methods and outlooks spread through the economy, follows the take-off; and this has led in some societies to a fifth stage of *high mass consumption*. This kind of growth, Professor Rostow believes, is still gathering momentum in western Europe and Japan, and has by no means ended in the United States.

There are far greater differences, of course, between the Marxian view of history and Professor Rostow's view than this mere listing of terms reveals. Professor Rostow, for example, points out how nationalism as well as the profit motive has figured in growth, how various sectors of the economy have stimulated the growth of the whole economy, how the type of leadership and the government's role changes as societies grow, and some of the interesting alternatives that arise. Communism is by no means the only route by which a society may grow, history has shown, and the resources resulting from modernization can be employed in any of several ways.

There have been three kinds of wars, Professor Rostow suggests: Colonial wars, arising from colonial powers' intrusions on transitional societies; limited aggression, as states in the early stages of modernization look backward to past humiliation and forward to new opportunity; and massive wars, arising from attempts to win hegemony over Eurasia and the world. He traces such struggles, cites communism's errors, and concludes that "the fate of those of us who now live in the stage of high mass consumption will be largely determined by the nature of the pre-conditions process and take-off in distant nations."

An editorial in *The Economist* pointed out the pertinence of Professor Rostow's analysis both to the West's current relations with Russia, and dealings with less developed nations. The Russian government, this editorial suggested, has three choices: To seek world power, to choose high mass consumption, or to advance toward human dignity and freedom. The West's problem is "to make the choice of a high consumption economy (and, if possible, of a freer society) as easy, as natural and as face-saving for Mr. Khrushchev as it can." A second task is "to cope equally imaginatively and sensibly with the other colossi that will be following close after.

"Even the most ardent enthusiast (for Professor Rostow's views)," says *The Economist*, "would claim no more than that they set down some familiar truths in a new and interestingly formalistic dress; those who are irritated rather than tickled by the way in which he may seem to claim to have invented a diabolical law of perpetual historical motion, and embodied it in a steamroller, can take comfort from the fact that his whole point is that this steamroller's eccentricities are possible to avert. The extent to which we succeed in averting them will determine the future of our age."

Dr. Wiesner's Responsibilities

THE additional duties of Acting Head of the Department of Electrical Engineering were assumed this fall by Jerome B. Wiesner, Director of the Research Laboratory of Electronics, and a member of President Eisenhower's Science Advisory Committee, the Army Science Advisory Committee, and the Department of Defense Science Advisory Committee.

"Dr. Wiesner has been a vital force in the enhancement of the work of the Department for a number of years," President Stratton noted in announcing the appointment. "He has initiated many important activities that have given the Department an enviable reputation as a center for graduate education. As a vigorous participant in the undergraduate activities, he also has contributed greatly to the work of his faculty colleagues in pioneering new syntheses of electrical technology and in their implementation in the form of a new curriculum and in the Course VI-B Option, Electrical Science and Engineering."

Foster Heads Lowell School

THE Lowell Institute School opened this fall under a new Acting Director, F. Leroy Foster, '25. Founded in 1903, this school has provided tuition-free evening instruction for hundreds of industrial workers. It offers three basic courses — Mechanical, Electrical, and Structural — which provide fundamental training in mathematics, physics, thermodynamics, hydraulics, testing materials, electrical measurements, structural design, and machine design. The classes meet at M.I.T. and the Institute is well represented on the school's faculty.

The Arthur D. Little Lecture

A DISTINGUISHED geneticist, Dr. George W. Beadle, who is chairman of the Division of Biology at the California Institute of Technology, will be the 1959 Arthur Dehon Little Memorial Lecturer. He will be in residence at M.I.T. during the first two weeks of November, and on November 16, at 8:00 P.M. in Kresge Auditorium, he will speak on "The Place of Genetics in Modern Biology."

On display here are some of the many books produced by men at work in the M.I.T. Center for International Studies.

Support for International Studies

AN $850,000 grant from the Ford Foundation, announced last summer, has partially relieved the Center for International Studies at M.I.T. from dependence on short-term grants. It will cover salaries of several senior members of the Center for 15 years, and provide for graduate fellowships and help defray other expenses for 10 years.

"The research publications of the Center have been widely and favorably known for a long time," John E. Burchard, '23, Dean of the School of Humanities and Social Science, observed when this was announced. "It has not been so generally appreciated that the Center staff has made notable contributions to our teaching program, graduate and undergraduate. In this our students have gained a great deal from the practical experience the Center's staff has gained in its work all over the world. But in this fruitful arrangement there has been an element of instability because a number of the senior members of this staff were not permanently attached to our regular Faculty. The present Ford Foundation grant will materially assist us in stabilizing this situation, in reviewing the gains already made, and in expanding on these fine beginnings."

Phosphorus Improves Teeth

PHOSPHATES in the diet reduce dental cavities, Robert S. Harris, '28, Professor of Biochemistry of Nutrition, told an international conference on oral biology in New York early this fall.

Ten years ago he and Dr. Abraham E. Nizel, '51, a Boston dentist and research associate at M.I.T., found that hamsters fed corn and milk produced in New England had poorer teeth than those fed corn and milk produced in Texas. By a long series of experiments, prompted by this puzzling difference, they found that the ash of foods acted strongly against dental decay when added to the diet of hamsters, and that it was the phosphorus in the ash which was responsible. A hamster's teeth, fortunately, develop about 20 times as fast as a man's. Now, by adding metaphosphoric acid pellets to hamsters' diets, they have grown animals with lustrous, pearly white teeth and no cavities.

"The development of knowledge of the relationship of phosphorus to dental caries," Dr. Harris said in reviewing his own and others' work, "is an interesting example of how several investigators trained in different disciplines, located in different countries, working with different experimental materials, and searching for the answer to different questions, make the same discovery.

"It has been known for many years that the enamel of teeth consists largely of calcium and phosphorus; that populations living on sophisticated diets containing significant amounts of refined cereals were susceptible to dental decay; and that animals fed semirefined diets containing as much as 70 per cent sugar, but well balanced nutritionally with animal proteins and vitamin and mineral mixtures, often did not develop dental decay. The combined results of research from several laboratories in recent years have helped to explain how the level of phosphorus in the diet may influence the susceptibility of animals and man to dental caries.

"Almost without exception, investigators have noted decreases in the incidence and severity of experimental caries when phosphorus was added to caries-producing diets. The data vary primarily because of differences in experimental conditions. However, the literature indicates that diets containing phosphorus are effective in the prevention of dental caries in rats, hamsters, and children."

(Concluded on page 58)

M.I.T. Dedicates a New Building

MRS. LAMMOT DU PONT, mother of the late David Flett du Pont, '56, formally presented the new Athletic Center that bears her son's name to M.I.T. at dedication ceremonies in the lobby of the new building on Monday, October 5. James R. Killian, Jr., '26, Chairman of the M.I.T. Corporation, presided; President Julius A. Stratton, '23, accepted the building for the Institute, and Richard E. Kaplan, '60, President of the student Athletic Association, eloquently expressed the appreciation of the students for the new facilities.

Mrs. du Pont spoke briefly, recalling the deep affection of her son for the Institute and his understanding of the need for facilities for "quick exercise," which inspired the $1,000,000 bequest to the Institute that made this building possible.

Dr. Killian recalled David du Pont's fine record as a student, declared that now for the first time in its history the Institute's facilities for athletics are truly adequate, and predicted that many generations will benefit from the thoughtfulness of the building's donor.

Dr. Stratton expressed the warm regard and esteem of the Institute for both David du Pont and his father, congratulated those responsible for the planning of this center, and declared that the new facilities will help the Institute realize the goals of its total educational program. "Society asks of most men," he pointed out, "more than sheer intellectual ability."

Mr. Kaplan spoke extemporaneously. He praised David du Pont's understanding of the attitude toward athletics at M.I.T., and stressed the importance of the program by noting the many ways in which it is "helping men grow." The new building, he said, will help the Athletic Association develop a still better program, that will draw more men into helpful recreational activities in student days.

His remarks were heartily applauded by the 250 guests, including several members of the Du Pont family, many members of the M.I.T. Corporation (which met in Cambridge that day), department heads, and distinguished members of the Faculty and Administration. Luncheon was served in the large new gymnasium of the building following the ceremony.

Dr. Killian then introduced Richard L. Balch, Director of Athletics at the Institute, who expressed his Department's appreciation of the new quarters, called attention to its numerous attractive features, and spoke of the goals of the M.I.T. athletic program. (His views are set forth in the article which begins on page 30 of this issue of The Review.)

Before inspecting the new building, Mrs. du Pont went to see the David Flett du Pont tennis courts, which were constructed because of her son's interest in tennis. She then toured the new facilities which will be used for many different sports.

Mrs. Lammot du Pont was shown the new Athletic Center by Richard L. Balch, the Director of Athletics.

Mrs. du Pont officially presented the building, which her son's generosity made possible, to the Institute.

David Flett du Pont, '56

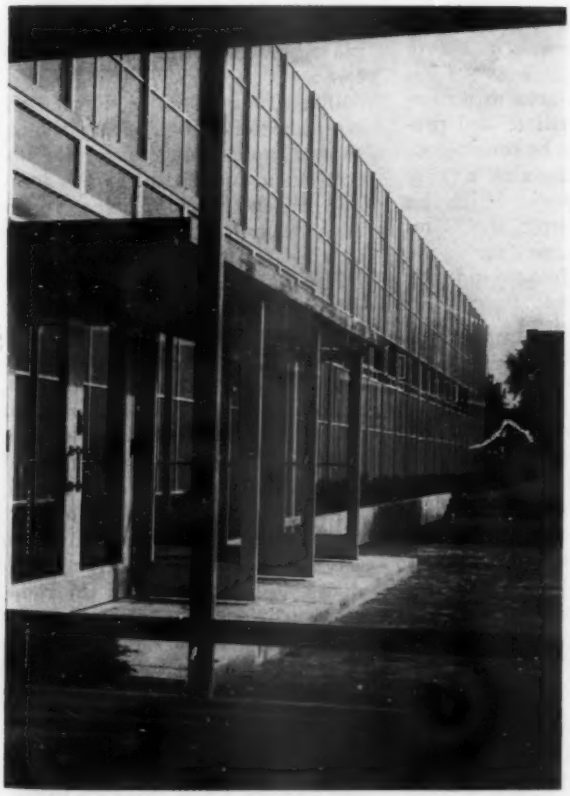
THE new Athletic Center at M.I.T. was made possible by a bequest of $1,000,000 from David Flett du Pont, '56, (at right), who was fatally injured in an automobile accident on Fisher's Island, N.Y., in the summer of 1955, shortly before he was due to return to the Institute.

His father was Lammot du Pont, '01, who died in 1952 after being President and Chairman of the Board of E. I. du Pont de Nemours and Company, Inc., and a term member from 1928 to 1933, and life member from 1934 to 1952, of the M.I.T. Corporation.

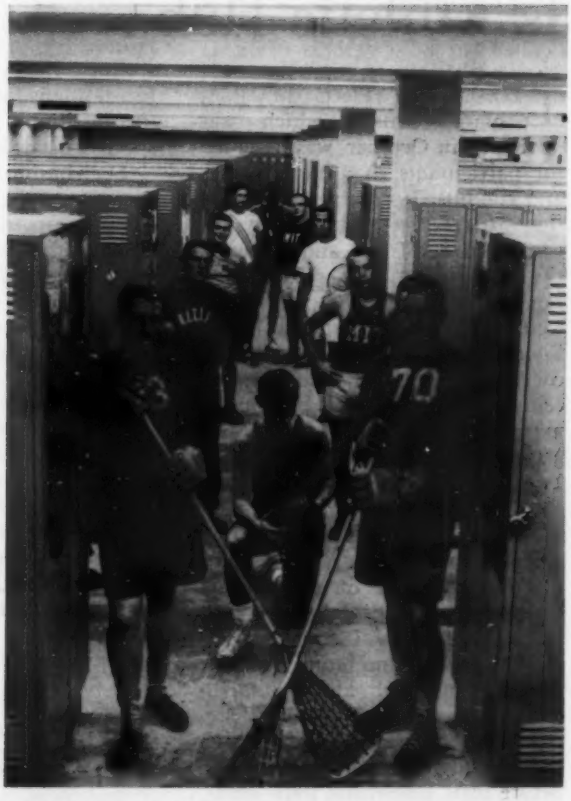
David du Pont was a 1952 graduate of the Tower Hill School who majored in metallurgy after coming to the Institute. His favorite game was tennis.

Part of his bequest was used to replace eight substandard courts in 1957 with 12 new ones. The David Flett du Pont courts (pictured on page 32) are considered the finest collegiate tennis facilities in the Northeast now. Six are all-weather courts, and six are fast-drying courts for match play. They have proven so attractive that about 600 undergraduates per year have been introduced to the sport or led to keep it up since they were built.

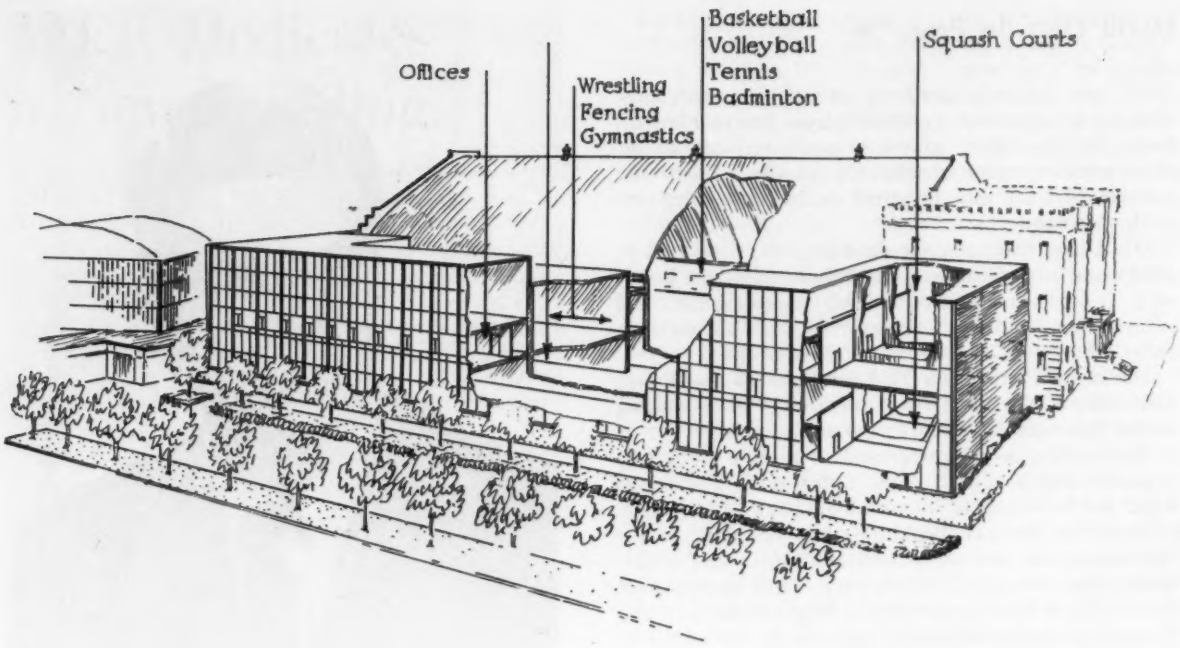
The David Flett du Pont Athletic Center is expected similarly to increase the extent of student participation in physical recreation. It will serve players in both indoor and outdoor games.



This glass wall faces Kresge Auditorium and the Chapel. The new building connects three older ones.



Lockers nearly fill the first floor. They are for participants in many different athletic activities.



Du Pont Center Is Athletic Hub

THE David Flett du Pont Athletic Center, which was dedicated in October, was designed for participants in athletic games and contests. It enlarges the facilities for recreation and physical education at M.I.T. and increases the usefulness of older buildings. It connects the Armory, the Rockwell Athletic Cage and the Briggs Field House, and gives teachers, coaches, and student managers a central headquarters from which many different kinds of physical activity, both indoors and out, can be enjoyed, stimulated, and guided. Its locker and shower rooms will accommodate more people than its spaces for spectators.

This new hub of recreational activities was built with $1,000,000 left to M.I.T. by David Flett du Pont, '56, of Wilmington, Del., for "improvement of athletic facilities." Four years of planning preceded its construction, and 18 different designs were worked out before final blueprints were made. The different shapes and floor levels of existing buildings, and future plans for the area, as well as the Institute's immediate and prospective needs had to be considered.

The building provides a new entrance to the Armory (which the Institute acquired from the Commonwealth two years ago), the Cage, the Field House, and the playing fields, which have been enlarged by removing temporary housing that was erected in wartime. It also enhances the appearance of the three older buildings when they are approached from the Charles River, the Kresge Auditorium, the Chapel, or the dormitories along Memorial Drive. Its 240-foot long window wall, which will often be photographed, gives the building the appearance of a three-story structure, although there are only two main floors.

In the lobby, letters carved in a slate slab spell out:

DAVID FLETT DU PONT
ATHLETIC CENTER
GIFT OF DAVID DU PONT
CLASS OF 1956

Here there are cases on the walls for the display of trophies won by Institute teams in the past, and up a short flight of stairs visiting Alumni will find photographs of many famous teams and players displayed on a bulletin board 60 yards long.

The ground floor is devoted almost wholly to locker rooms, showers, and storage space for the equipment used in the gymnasiums and on the playing fields. In its largest room, 50 by 147 feet, there is the greatest concentration of lockers anywhere on the Institute's campus. Nearby are dozens of showers for men, a separate room for visiting teams, a trainers' room containing therapeutic facilities, and a 20 by 36-foot locker room and half dozen showers for women.

Above these dressing rooms is a 48-foot wide multi-purpose gymnasium, with hardwood flooring over cork, fluorescent lighting, and two sets of 16-foot high folding wooden doors. With these doors, the room can be divided when desired into a 70-foot long room for wrestling, a 59-foot long room for fencing, and a 43-foot long, well-equipped room for individual exercise.

Across a corridor from this gymnasium is the huge drill floor of the Armory, where there are basketball, indoor-tennis, badminton, and volleyball courts. Across a corridor

on the other side of the new gymnasium are the offices of the directors of athletics and physical education, the coaches, student Athletic Association officers, and student managers. Here there is also a conference room, and a locker room for the use of the Faculty and coaches.

These corridors, incidentally, are a feature of the building that interests planners of commencement exercises, Alumni Day dinners, and other such events as well as athletic managers: They will enable processions, dinner guests, and other visitors to go from one building to another without stepping out into the hard-to-predict weather of Cambridge.

At the eastern end of the 80-foot wide structure, directly behind the brick wall which faces Massachusetts Avenue, there are six new squash courts, three on the ground floor, and three above. Spectators' galleries run the length of each set of three courts, and are entered from different levels than those on which players come and go. Behind these courts, above the offices, are the machinery and piping for the hot water and steam services and the heating and ventilating.

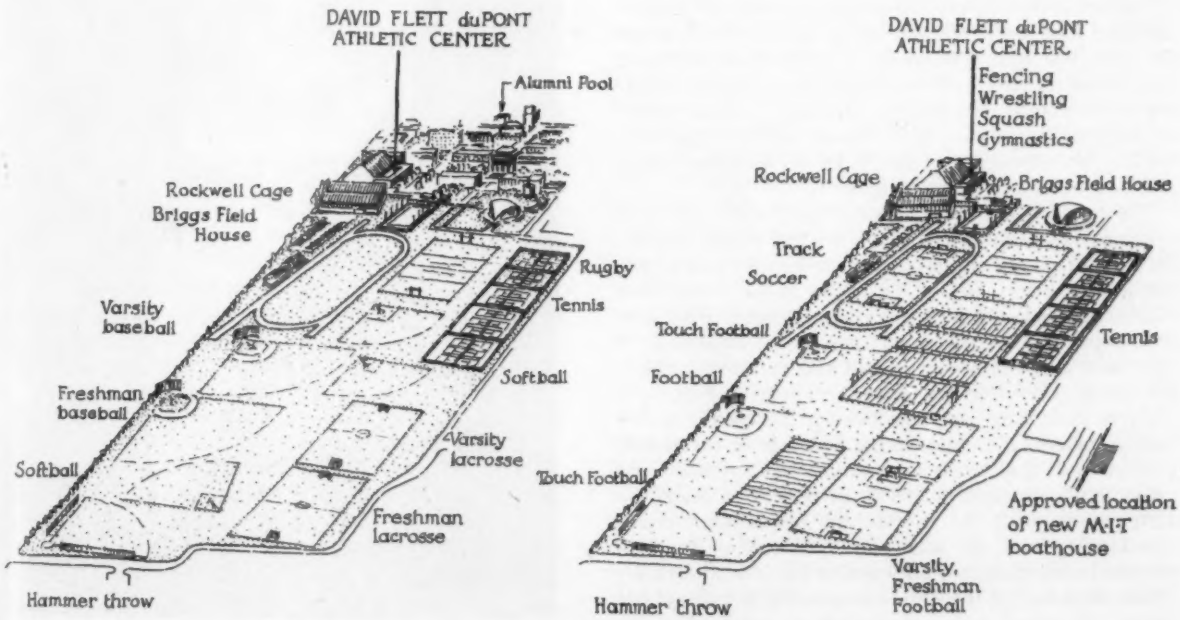
From top to bottom, there are innovations in the building which have intrigued the sidewalk superintendents of its construction. Part of the roof, for example, is reinforced concrete, two feet two inches thick, but lighter than its appearance suggests because inside it are wax-coated, hollow cardboard tubes, closed at both ends. This method of providing an economical structural slab is just coming into general use.

The most distinctive feature of the building, however, is now well concealed beneath it. This is its foundation, which differs materially from those of all of the other M.I.T. buildings. Below the building there is a bed of soft clay, covered at a depth of about 20 feet by a crust of sand and gravel, and the building rests on piles which are anchored in this crust by pressure-injected footings that spread the load over the clay.

These piles, commonly called "displacement caissons," or "pressure injected footings," were pulled into the earth by a method devised in Belgium nearly 50 years ago by Edgar Frankignoul. It has since been introduced on all six continents, but has been used for only a few years in the Boston area. It was brought to this country by the Franki Foundation Company, of which Leon A Fraikin, '31 is now chairman of the board. This company installed the 215 piles that support the new Du Pont building.

No excavating is needed for a Franki foundation. A hollow manganese steel tube, 20½ inches in diameter, is erected at the spot where the plans call for a pile, and the lower end of this tube is plugged with a few cubic feet of dry, granular material. A 7,000-pound ram, falling 20 feet, strikes this plug, and drives it into the earth; surprisingly, it pulls the tube down with it. When the desired depth has been reached, the tube is anchored tightly to the driving rig and the plug is knocked out with more 140,000-foot-pound blows. Damp concrete is then poured down the tube, alongside the ram, and driven out the lower end of the tube until a large bulb has been formed as a footing.

The architects were Anderson, Beckwith, and Haible and construction of the building was undertaken by the George A. Fuller Company in February, 1958. The structural engineers were Severud-Elstad-Krueger Associates of New York; Delbrook Engineering, Inc., Cambridge, were the mechanical engineers, and Edwin P. Mahard, the electrical engineer.



THE PLAYING FIELDS OF M.I.T

The Role of Athletics at M.I.T.

BY RICHARD L. BALCH

A recreational program in which thousands participate helps refute the cult of easiness, and helps develop the universal man . . . the Director of Athletics writes

AFTER six years as Dean of Men at Stanford and, prior to that, two years as an Admissions Officer at Union College in Schenectady, N.Y., I became convinced that American universities must decide whether an athletic program is a part of education which affords purposeful recreation, or is a business through which universities finance a part of their educational obligation.

It occurred to me that an attempt to develop an athletic program which is a part of education could best be made by an institution in which gate receipts were not charged. Recreation for students then would have to be the basic reason for the existence of the athletic department.

I also felt that it was unnecessary to enlarge administrative staffs in personnel offices if one could select the right coaches to teach in an athletic department. As a Dean of Men I often found that insight explaining a boy's behavior could be obtained from members of the coaching staff. To call each coach, in his particular activities, an ex-officio Dean of Men would not be a misnomer in my judgment.

These ideas first came to me while I was serving as a Motor Torpedo Boat Officer in the South Pacific. I noticed that the officers and men who seemed to get the job done and survive the rigors of war were those who combined brains with previous competitive athletic experience. Their experience on the athletic field had been a test of both physical and emotional stability which proved of considerable worth in war.

After observing the relationship between a coach and a student, it seemed to me that one of the closest personal ties that exists in a young man's educational career had not been properly utilized. Too often, we have been guilty of overlooking the student-coach relationship and, in addition, have tended to push physical education and athletics to one side and rarely relate them to the academic community. We have been more concerned with attempting to rationalize the existence of college athletics than with identifying them as an important educational tool. If a stimulus

Richard L. Balch is associate professor of physical education, director of athletics, and head of the department.

to learn could be developed in all classrooms which could capture the elements of initiative, concentration, perfection, and pride inherent in athletic achievement, the art of teaching could return to the prominent and respected status it once enjoyed.

At M.I.T. we have attempted to promote a program in which each student is given the chance to experience some physical activity. We have made available those sports which may be enjoyed both in college and in later life.

It is my hope that more of the other universities in the United States will remove themselves from the temptations of the entertainment business and return to the job of stimulating the vast resources of the human mind and spirit.

Participation at M.I.T.

During the 1958-1959 academic year, 3,182 M.I.T. students were registered in 30 physical education classes, about 3,500 men played on the 421 teams that competed in 14 kinds of intramural contests, and one out of every four students participated in one or more of 19 intercollegiate sports.

Our particular athletic program, tailored for a university in which science rather than football is the emotionally integrating symbol of the campus, has been evolving since the Institute was founded nearly a century ago. As in other schools, student interest sparked, if not organized, the 19 teams that now compete on an intercollegiate level. They were aided and encouraged by the former Alumni Advisory Council on Athletics which was organized in 1898 and served continuously until succeeded by Ivan J. Geiger as Athletic Director in 1947. Athletic Council members (Major Frank H. Briggs, '81, Dr. John A. Rockwell, '96, Henry E. Worcester, '97, Dr. Allan Winter Rowe, '01, Ralph T. Jope, '28), Mr. Geiger, and others have preserved the continuity and the gradual development of facilities has encouraged the growth of this program. Now the Institute's facilities are comparable to those of any other prestige university in the country.

Thanks to the careful planning of our predecessors, we are not concerned, as many institutions are, with the problem of filling a football stadium while maintaining complete integrity as an academic institution of "high degree." We can state with confidence that our policy is to provide an athletic program for the individual student which serves our educational objectives and provides wholesome recreation. In so doing, we encourage a maximum of student participation in athletics, promote student responsibility in management, and give vigorous support to the interests of students who engage either in intramural or intercollegiate competition.

The Athletic Director's responsibilities at M.I.T. do not include the administration of a sideshow competing with others in the entertainment world. There simply is not room in the curriculum for an athletic program outside the broad definition of recreation, which is "to refresh in strength or spirit after toil or anxiety." Our intercollegiate contests are recreational rather than a means of procuring funds for the support of all or part of the athletic program.

Emphasis has been placed in this program on teaching or enhancing skills in recreational activities that may be carried on in later life. A student does not have freedom of choice among an endless array of activities; our physical location precludes some. But there is a wide spectrum from which the undergraduate can choose in class programs, intermural, and intercollegiate sports.

The Universal Man

In describing what we are doing in the Athletic Department, I prefer to bypass categories of "the well-rounded man," "the whole man," and other terms having to do with the symmetry of the body.

"The universal man" is a more definitive term. To quote Webster, such a term describes a man "versed in or embracing, a wide range of subjects, pursuits, etc." Universality suggests the magnitude of the education available at M.I.T. and the caliber of man who ought to be involved. "The universal man" is a phrase that conveys the breadth of the ultimate purpose of a university education. That purpose, to me, is basically to produce individuals — even some lop-sided ones — who are willing to accept the challenge and responsibility of critical thinking.

The men employed to teach physical education and to coach intercollegiate sports are asked to learn to know the individuals, their capabilities and limitations, and always to keep an eye on their academic records. The athletic staff has been able to supplement the collective effort of the Faculty to gain insights regarding the undergraduates. Brief statements, written by the coaching staff, of the extra-class efforts of students are sent to deans, department heads, and registration officers, whenever such knowledge appears likely to be useful. This eliminates much of the busy work of student personnel offices in other universities.

Automation has not replaced the human element at M.I.T. After four years' observation, I believe M.I.T. is whatever a student wants to make it. He can, if he chooses, sit at his place of residence and visualize the entire community as an impersonal degree factory, but he has the alternative of devoting part of his leisure hours to participation in the breadth of an M.I.T. education. He may join the Choral Society, Student Government, The *Tech*, any of a multitude of clubs, or participate on an athletic field. The only demand made upon the individual is that, when he makes a choice, he must do so with a sense of responsibility to contribute his best. The difficulties faced by many students in this regard are basically the result of being lost in a maze where responsibility is confused with authority and freedom to act is mistaken for license.

The athletic staff's mission is to expand the opportunities for self-evaluation and enlarge the choices that each individual has made during his first 17 or 18 years of life, rather than to seek perfection of athletic prowess without regard for educational goals and individual differences. To promote maturity, it is necessary that we re-enforce the student's understanding of the role he undertook when he matriculated at M.I.T. Each student must become increasingly aware that his choices become more meaningful to him as he advances.

Particularly is this true for M.I.T. students in an age when the understanding of science may be a

determining factor in world politics. The contribution our students make, regardless of their specialties, may well be the ability to interpret scientific thought for those less well informed in conceptual realms of science. It is the purpose of the athletic program to foster physical fitness, emotional control, leadership, and the development of recreational habits. By this effort we hope to aid in building a universality of experience that will provide a base from which an M.I.T. graduate may be able to impart his professional knowledge.

Discouragement of Nonchalance

A pseudo-sophisticated attitude toward athletics has become fashionable in America. The vast majority of students have become spectators rather than participants. Our goal is to discourage the nonchalance toward participation that has been encouraged by technological developments of our time, and not to pamper professional athletes. The cathode-ray tube has given us an important new medium of communication, but television has brought with it brain washing, deprivation of independent thought, conversational idiocy, and still worse, mass encouragement of mental and physical inactivity. (In this particular context I was delighted with a small sign in the University of Wisconsin library, while visiting there recently. The sign read: "Books are quiet. They do not dissolve into wavy lines or snowstorm effects. They do not pause to deliver commercials. They are three-dimensional, having length, breadth, and depth. They are convenient to handle and completely portable.") We as an institution and the athletic staff in particular must help to reduce the new knowledge of our age to physical and mental health.

We must remember that the "fittest" survive, and that nations must practice as well as give lip service to self-imposed discipline. We must not be guilty of developing a civilization of weaklings, dependent on the ever-increasing luxuries of the electronic age and the psychiatrist's couch. We have an obligation as a "university polarized around science" to make certain that we unconsciously do not become guilty of developing man's mind and knowledge to the point of physical decadence.

Fortunately we do not have to face the dilemma of many college athletic programs described a few years ago by Dr. George L. Cross, President of the University of Oklahoma. "We are working," he said, "to develop a university that the football team can be proud of." The M.I.T. athletic staff is engaged in building an athletic program that will equal the academic standards of the university.

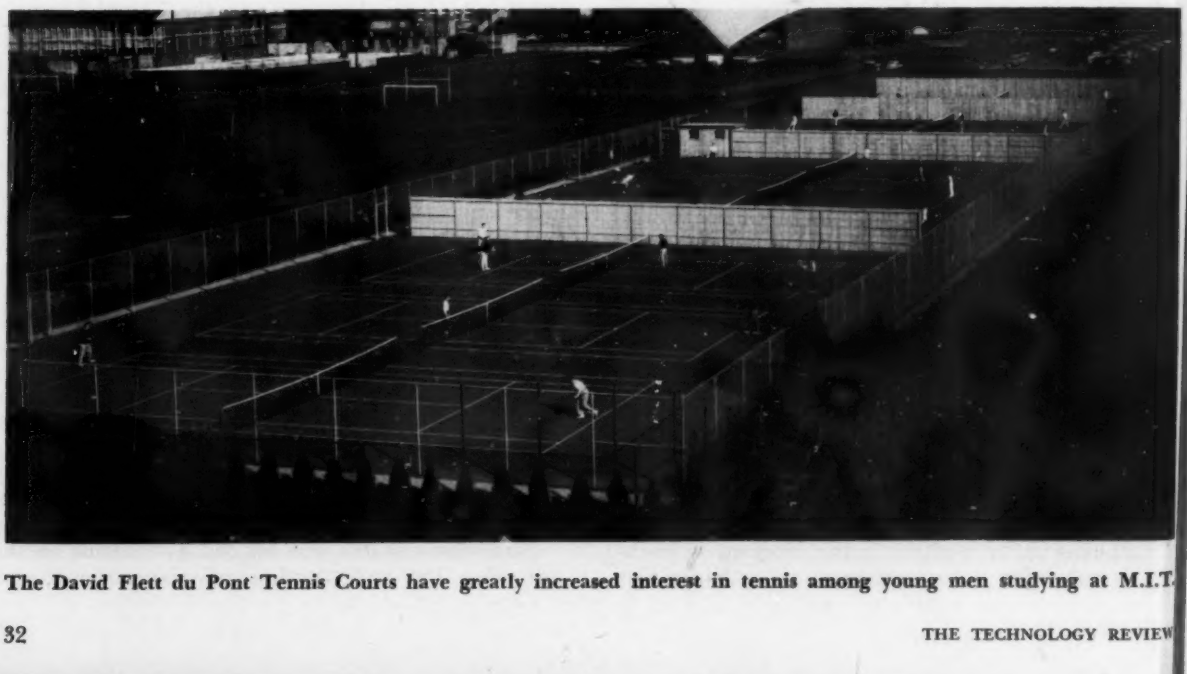
Today men are specialists, speaking languages only a few others understand. The physicist has difficulty understanding the poet and the lawyer is frequently lost in the language of mathematics. We cannot ask that one man assimilate the current rapid expansion of knowledge in all fields. The men we are responsible for educating at M.I.T. will be forced to weigh a variety of expert opinions.

Many men have found an opportunity for sober reflection, and to learn the language of others, while engaged in diversionary activities. Much of this diversion comes under the general heading of recreation. To this end, we feel the M.I.T. student and American university students generally, can profit from participation in purposeful, thought-out programs of physical exercise. The greater the purpose, the more we ensure ourselves against loss of brainwork because of physical or mental illness.

Facilities at M.I.T.

The West Campus facilities have been greatly changed, with the encouragement of Presidents Compton, Killian, and Stratton, and Dr. Stratton pinpointed the objective when he stated recently that "from the maturing influence of campus life should come a wealth of experience and understanding gained through informal relations with faculty and fellow students."

(Concluded on page 50)



The David Flett du Pont Tennis Courts have greatly increased interest in tennis among young men studying at M.I.T.

The Coaches' Review of M.I.T. Athletics

Lacrosse players, skiers, tennis men, and swimmers were victorious in 1958–1959

In the brief reports which follow, M.I.T. coaches review the 1958–1959 athletic season and indicate prospects for the coming season:

Lacrosse Team

The 1959 M.I.T. lacrosse season was the greatest in the school's history. With 11 victories in 12 intercollegiate games, the team won national recognition as coholder with Lehigh of the championship Roy Taylor Division of the U.S. Intercollegiate Lacrosse rankings. Led by Cocaptains Larry C. Boyd, '59, and Charles T. Fitzgerald, Jr., '59, who set a new Tech record of 33 goals for one season, the team lost only to New Hampshire in a 6–4 contest. Coach Martin was chosen to direct the North team in the North-South All-Star game, and Cocaptain Fitzgerald was selected as a player for the North squad and given honorable mention in the All-American selections. – Benjamin R. Martin, Jr., Coach.

Ski Team

The Ski team started the season with skiers of average ability and little racing experience, under a new and "green" coach, and through diligence, enthusiasm, and industry the men molded themselves into a championship team. The team was ably captained by Knut Hauge, '59, managed by Theodore H. Ansbacher, '60, instructed in racing technique by Bard Glenne, G, and coached by Air Force Captain Robert C. Shoemaker. The team worked on physical conditioning two months before the first meet. During Christmas vacation, the men went to Sugarloaf Mountain, Maine, for skiing practice and learned a great deal about racing, skiing in general, and each other. There the group developed the personality and philosophy of a team, which contributed more than any other factor to the team's success.

Our races were held on every other weekend, beginning January 21. The team placed fifth in its first race, then placed second, first, first, first, first, and third in that sequence; and accumulated enough points to win the team championships of the New England Intercollegiate Ski Conference.

Four seniors and three freshmen comprised the "A" team. The captain for next year is Ted Ansbacher, who for the last two years has served as a player-manager. Ted, with his maturity, sound judgment, and experience, will provide strong and wise leadership. The manager for next year is Peter P. Goldstern, '62, who last year was assistant manager. With a nucleus of talented and experienced freshmen to build a team around, M.I.T. can look forward to another successful skiing season. – Capt. Robert C. Shoemaker, U.S.A.F., Coach.

Swimming Team

This year the Swimming Team had an outstanding record in both dual meets and championships. We finished a 10-meet schedule with a 7-3 record, losing to Harvard, Brown, and Springfield, and defeating Bowdoin, Rensselaer Polytechnic, Tufts, Trinity, Wesleyan, Coast Guard, and Worcester Polytechnic. The 46–40 loss to Springfield was a heartbreaker; two second places instead of thirds would have made the difference.

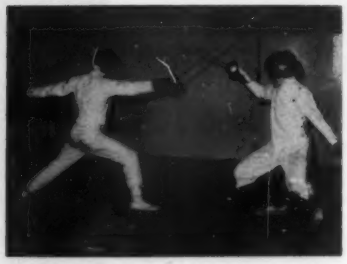
Our season was climaxed by a superb performance in the New England championships, where M.I.T. scored 32 points, finished fourth in the league behind Williams, Brown, and Springfield, and placed men in the finals in the medley relay, backstroke, breaststroke, 440, 400-relay, and the diving. Following the New Englands, we went to the Easterns at Yale, where our medley relay of Theodore N. Divine, '59, Burnell G. West, '60, Thomas J. Ising, '61, and Roger G. Kane, '59, qualified fifth for the finals in the excellent time of 4:07.6, defeating Dartmouth and Cornell, and breaking the existing M.I.T. record of 4.09.3. In the finals, they did not go as well, and finished sixth. In general, it was a most satisfying season. We broke four M.I.T. records: the medley relay, the 100-butterfly (Tom Ising – 1:01.9), the 100-freestyle (John P. Windle, '60 – 54:0), and the diving, when David A. Cahlander, '59, trounced the Harvard divers in their pool, defeating them by 15 points.

We were most fortunate this year in obtaining the services of Ronald Keenhold, former Eastern Intercollegiate Diving Champion, as freshman swimming coach. He has done an outstanding job, and turned out the best freshman swimming team in M.I.T. history. Despite our losses, through graduation, on the varsity level, we should be able to hold our own next year, although we will sorely miss Neil Divine in the backstroke, and Captain Roger Kane, Robert E. Brooker, Jr., '59, and William J. Kossler, Jr., '59, in the sprints. – Charles Batterman, Coach.

Crew

On the basis of the crew's record at the Championship Regatta of the Eastern Association of Rowing Colleges this year, the season was our best in eight years, and the heavyweight squad as a whole exceeded all previous performances.

Not since 1951 has the M.I.T. Varsity Heavyweight Crew attained "average" performance based on its relative standing in the field of competition in this event. That year we were sixth in a field of 11 and our crew contained many oarsmen from the 1950 National Sprint Champion crew.



This past season we were seventh in a field of 13, defeating, among others, Dartmouth, Princeton, and the Wisconsin crew which went on to win the Intercollegiate Rowing Association regatta.

Also at the E.A.R.C. regatta, our freshmen and junior varsity qualified for the afternoon consolation races by placing second in their heats, defeating Syracuse and Yale, respectively. Thus, for the first time, M.I.T. placed all her crews in the afternoon races. In this feat, we shared honors with four recognized rowing powers — Cornell, Harvard, Pennsylvania, and Navy.

Unfortunately, we were unable to continue this excellent showing at the I.R.A. There we placed 10th in a field of 11, where we have finished in five out of the last eight years.

The lightweight season, although disappointing in race results, produced the largest turnout of oarsmen in many years. Three varsity boats were on the water almost every day this spring. We had the misfortune, however, of meeting the national champion Harvard crew in each of our five races this year. Although our performance improved during the season, we could not catch the "Harvards" who went on to win again both the E.A.R.C. Sprint Championships and Thames Challenge Cup at the Henley Royal Regatta. — Jack H. Frailey, Head Coach.

Tennis Team

The 1959 Tennis Team opened its season with a southern trip, playing matches against Georgetown, Davidson, and North Carolina State, and began the regular season in better condition than we would have otherwise. Our regular season was the best we have had in the three years that I have been at M.I.T. We played 14 matches, winning 10 and losing 4.

The morale of the team remained high despite a 9–0 loss to Harvard in the first match. We defeated Army 6–3, then lost to Brown 6–3. We went on to win 9–0 over Boston University, Bowdoin, and Colby, and 8–1 over the University of Massachusetts. Our next match was against Williams, which we won 5–4. This was the first time that M.I.T. had defeated a Chaffee-coached team in the 20 years that he has been at Williams. We won over Rensselaer Polytechnic 9–0, and then lost a 5–4 decision to Amherst after winning four of the six singles. In our remaining matches, we defeated Wesleyan 6–3, Coast Guard 9–0, and Trinity 6–3, and lost to Dartmouth 9–0.

The New England Intercollegiate Tennis Tournament was held at M.I.T. this year. It had a record entry of 18 colleges and 69 players. Harvard won with 25 points; M.I.T. and Yale tied for second place with 20 points, and Williams placed third with 14 points. — Edward A. Crocker, Coach.

Soccer Team

The 1958 soccer season was a winning one, but a little disappointing. We played a difficult schedule, having four games in the first eight days, and opening with perennially tough Amherst. In addition, there was an unusually high number of injuries.

The highlight of the season was our final game with Dartmouth. We went to Hanover with 13 men and used 12 in the game. Dartmouth had defeated Yale and Amherst, and Amherst had really trounced us early in the season. M.I.T. played a magnificent game, winning 2–1, and displaying the kind of drive and spirit necessary to make up for our lack of numbers. In addition, we had the services of Philip J. Robinson, '61, and Ernesto J. Macaya, '60, both of whom had been sidelined most of the season with separated shoulders. Subin Banharnsupvat, '59, playing his second game of the season, was the playmaker and stabilizer.

We lost a very close one to Harvard, because of the much publicized play of the Aga Khan, the Harvard outside left. With four minutes left in the game, and M.I.T. ahead 3–2, the Aga booted a wind-drifting fluke shot that caromed off the goal post into the goal to tie the score. Harvard then scored again to wrap it up in the last minute of play. M.I.T. won another exciting game against Middlebury, in overtime, 4–2.

Two superior goalies, both former basketball and lacrosse players, were trained this season. They were Phil Robinson and the ubiquitous Joseph R. Skenderian, '61, who shut out Tufts 2–0 in the first game he ever played, and after only one afternoon of practice. Six men were named on the All New England Team, including our Captain-elect Fouad M. Malouf, '60, an oustanding fullback whose play was consistently excellent. We look forward to an improved record next year, and have begun, for the first time, plans for spring practice. Our season record was 5–4–2. — Charles Batterman, Coach.

Varsity Basketball

The team's record of three wins, 13 losses, does not, in any way, show the closeness of all but three games (Harvard, Boston University, and Springfield). The wins were recorded over Bowdoin, Tufts, and Clark. There were one-point losses to the Coast Guard Academy, Trinity, and Middlebury.

Captain Robert J. Polutchko, '59, led the team in every department. Hugh Morrow, 3d, '60, was second to Polutchko in scoring. Lack of height and court experience showed in the games played. With a good group of boys coming up from the frosh, plus reasonable scheduling of games, the record should be better. — John H. Burke, Jr., Coach.

Squash Team

Our season's record was two wins and nine losses. We defeated Adelphi and Connecticut 9–0. However, the team as a whole was greatly improved over the previous season and many of the individual matches were quite close.

Harvard defeated us 7–2, but this was the first time in the three years I have been coaching that we have taken any points from the always strong Harvard team. Loutfy ElSherbiny, '61, a sophomore playing number six, won a close five-game match and F. Monroe Labouisse, Jr., '61, playing number nine, won a close five-game match. Against Navy, the Intercollegiate Team Champions, we won the number one and two matches after being down two games to one in both matches. Farid W. Saad, '61, at number one, and Raul B. Karman, '61, at number two played magnificently in coming from behind to win.

(*Continued on page 68*)

There is a great deal about magnetism, research, war work, industry, and education in Magnets, *a book published this year by Doubleday as part of the Science Study Series prepared under the direction of the Physical Science Study Committee of Educational Services, Inc.*

There is also a great deal about the author, who is Professor of Physics and Associate Dean of the School of Science at M.I.T. This article consists of excerpts from this unusual new book.

Recollections of a Scientist

His family predicted he would be a lawyer . . . he wanted to study chemistry but became a physicist . . . and found life like standing in a waterfall

BY FRANCIS BITTER

Francis Bitter left the Westinghouse Company to join the M.I.T. Faculty in 1934 as a metallurgist, after the late President K. T. Compton had heard him speak at a physical society meeting.

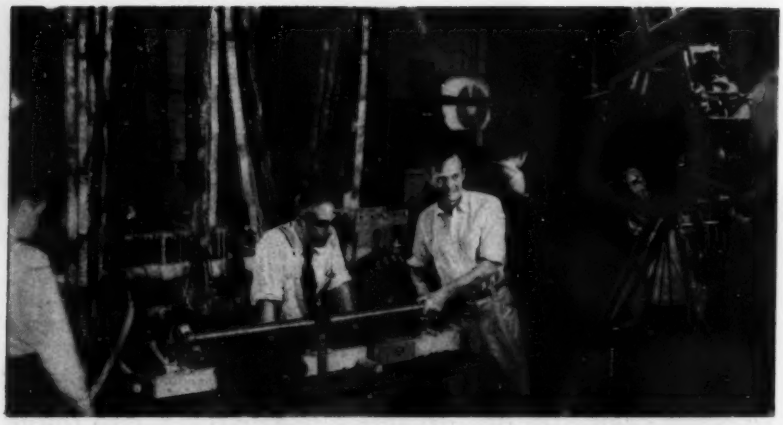
WHAT sort of a child is it who later becomes a physicist? Are there recognizable signs in childhood? I would say not. There is no rule to apply to sort out the scientist from the person who happily will pursue some other vocation. In my case I would say two qualities of character were important, and they have stayed with me through the years. One is imaginativeness. The other is an inquiring mind. Because I seldom accepted the statements or instructions of others, my family used to predict that I would become a lawyer. I would argue interminably, but the sorts of things that I argued about did not in the end center on legal matters. They centered on the description and understanding of the world around me.

One of my earliest recollections in this connection is of Sunday walks in New York City's Central Park, with my father wearing a high hat, my brother and sister and I in our Sunday best. Doubtless we discussed many different things on these sunny Sunday mornings, but I remember particularly the stories of the origin of the world — how rocks and the earth were formed, how living things appeared on the earth, eventually men like ourselves — and how cities grew. My father, a sculptor, was a great reader, and knew a good deal of natural history. His discourses fascinated me.

Life in our New York studio apartment was relatively uneventful. We children were brought up on a rather strict schedule. We learned and used three languages: German with our parents, French with a governess, and English in school. Piano lessons, dancing lessons, a little military drill with the Knickerbocker Greys in the Seventh Regiment Armory, visits to the Museum of Natural History on rainy days, reading "good" books on Sundays — such was the stuff of which our home life was made until, at 12, I went to boarding school.

One of our favorite games was called *enfant perdu* or "lost child." One of us pretended to be lost, destitute, deserted, in a completely hopeless situation, and another of us would find this lost waif. The foundling was adopted and gradually introduced to his or her "new" life. First we would exchange anecdotes about the real or imagined past. Then we would show off the magnificence of a New York elevator apartment, the "new" customs of the family, "new" foods at the table, "new" clothes and toys in our children's closets. The waif would be sent off to a "new" school, and our old friends would become his "new" friends.

The game took several days and,



Professor Bitter appears in one of the films produced by Educational Services, Incorporated, for use in connection with the new high school physics course. This picture was made in his laboratory during its production.

as I remember it, we played it not once but many times. It seems to me now that this may well have been an appropriate exercise for a future scientist. Scientific investigations are started and discoveries are made as the result of a repeated review of well-known facts, attempts to rearrange them, to see them from a new point of view that will excite new interest and reveal new possibilities. And this is just what we were doing in our children's world.

This *enfant perdu* game we played, as I remember it, when we were 9, 10, 11 years old. Another event that stands out in my mind must have happened in my early teens. I was paddling a canoe on a clear night and letting my thoughts roam. Suddenly it came over me, and with something of a shock, that maybe everything I considered most real was pure imagination. The lake, the canoe, the paddle, the stars, the night, the trees, even the feeling of water on my hand, might merely be sensations. Indeed, it might be that I was the only person who existed in the world, that my father and mother, my brother and sister and friends were all just figments of my own imagination — that the feeling of the solid earth when I walked on it was only a feeling. There seemed to be nothing to disprove the hypothesis. On the other hand, what would be the sense of such a thing?

It occurred to me that possibly this was all a matter of education. Perhaps really I was not a young boy alive here on the world, but one of a group of other kinds of beings, perhaps a god or supernatural being of some sort who was merely going through a course of training prepared for him by other supernatural beings. At the time, no one seemed particularly interested in this form of nonsense, but when I studied philosophy in college it was somewhat of a thrill to realize that I was by no means the first person to have considered the possibility.

• • •

At my high school the curriculum included no science whatever. We did have excellent courses in algebra and geometry, which I loved far above anything else. These subjects were easy for me and, if my recollection is right, I was one of the best students in the class. Solving problems by means of equations with unknowns, proving theorems on the basis of postulates — these were exciting, far more interesting than Latin and history, English and geography.

Presently I was ready for college. My grades in general had not been particularly good. On the other hand, I had never had to work particularly hard. Unlike many boys, I was not interested in wiring doorbells and building radios. Such pastimes seemed either boringly trivial or too complicated for me to understand. But when I entered college I had a notion — I remember it vividly — that I wanted to get to the bottom of certain kinds of magic; for example, I wanted to know what a magician did when he poured a liquid of one color into a liquid of another color and transformed it into a liquid of a third color.

My first request on registering as a freshman at the University of Chicago was to be allowed to study chemistry in order to understand this. I was told that physics was a prerequisite for the chemistry courses. The prerequisite opened a very long detour for me. In fact, I never got around to studying the mysterious changing colors of chemical compounds. In all my university days I have had few chemistry courses. For me, it turned out, the physics courses were more satisfying.

• • •

Science and mathematics were easy for me. I did not have to work very hard to get by. My family was not well off, but even in those days, before easy fellowship support, I was able to borrow money to see me through college. One day I saw a notice of a competition for a cash prize to be awarded for excellence in applied mathematics. If I should win that, it would be a most welcome addition to my pocket money. I took the competitive exam, and I still remember the cocky feeling I had when I looked around and saw no one I considered a serious rival. I was very confident. But when the results were announced, it was not I who had won. It was an unknown. Someone who had not become a member of the discussion groups, the bull sessions, the argumentative lunch clubs, just someone who was quiet and smart.

As I now think back on this time, I am reminded of a children's party that my wife gave recently. One boy was somewhat older than the rest. He was rather disdainful and obviously felt superior. Toward the end of the party we had a competition — to see who was best at tossing cards into a hat. It looked easy. The various children tried with negligible success. At last it was the turn of the older boy. He strutted up and obviously expected every card to land in the hat. The first went wild. He looked sheepish. The second went wild. He looked embarrassed. The third, fourth, and fifth he threw in rapid succession, but all missed. With a bewildered look he turned to us and said,

"Hey, what's wrong?"

That was just my feeling when I failed to win the competition — "Hey, what's wrong?" I had not yet learned that singlehearted hard work and devotion and even love were necessary for any *success*, for any real achievement. If these ingredients are not there, one cannot contribute or benefit as one might. It was a good lesson to learn at the very beginning of my career. And there were many more.

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Before starting graduate work I decided to take a year off to study physics more or less independently in Berlin, and a very exciting year it was. I listened to many very famous lecturers: I heard Max Planck, the father of quantum theory, on thermodynamics, which I think he loved more than any other subject; Max von Laue, who had discovered the diffraction of x-rays by crystals and ran the colloquium where every week new discoveries and ideas were discussed; and Albert Einstein. I well remember the colloquium at which Erwin Schrödinger's wave mechanics was introduced. I took the subway home that night, and noticed Einstein coming into the train behind me. Although I had not met him formally, he evidently recognized my face as having been in the audience that afternoon, because he started right in: "What did you think of that? What a marvelous time to be alive!"

And, perhaps for the first time in my life, I worked really hard by myself. I bought the two-volume, paperback *Theory of Electricity and Magnetism*, by one of its founders, Max Abraham, and studied it from cover to cover. Between bouts of study I spent hours thinking and trying to understand what the book *implied* as well as what it said. I made many good friendships among the graduate students and young instructors and research workers. One was Herman Mark, now a professor at Brooklyn Polytechnic Institute, who wrote an article on large molecules for the September, 1957, *Scientific American* that I recommend to you. And there was Leo Szilard of the University of Chicago, who has been a key figure in the initiation of many new ideas, including nuclear reactors and explosions (see Smyth Report on the Manhattan Project). They were some of the people with whom I would discuss what I was learning, people who would share my enthusiasms, correct my mistakes when I got off the track, suggest books, and point out when my bright ideas had been anticipated years before. I was very absorbed.

For many years, Professor Bitter has been developing powerful magnets to study the magnetic nature of matter. This photo, made in 1934, shows him with a small magnet that "swallowed the output" of two big generators.

One day as I was walking along a busy street, a girl passing me said, "*Gutten Abend, Professorchen.*" Well — perhaps if it was as obvious as all that, the "Professorkins" might really have it in him to become a professor.

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Life is in many ways like standing in a waterfall, or so it turned out for me. Either you have the pleasure and the excitement of staying in the waterfall or you get out. I really much prefer to take on the challenge of whatever comes along, provided it really interests me.

So there has been, first of all, the challenge of teaching. How can one be a part of a place full of young people and not concern oneself with what is told to them about the past and the prospects of the future? How can one turn down the privilege of helping to decide what is worth saying and what is not? I could not. So there goes time out of research in the laboratory with graduate students.

And then comes the application of what we have learned. How can one turn down the privilege of going out into industry or government, where what we know is put to work to make things that we want?

Finally, there is the running of the Institute itself. People who have been around a farm all their lives get a certain knack about when to water, when to plow, when to put in fertilizers to make the fields produce. They learn things that are hard to put down in a book of rules. And so it is with professors at a university. More and more, as your hair turns grey, you are asked for advice, you are asked to sit at long meetings that are not nearly as interesting as it used to be to work in the lab. But it is a great satisfaction to see new laboratories being set up, to see new experiments being started, to arrange for the teamwork that is needed in so many modern ventures. It is important to lend a hand in steering the growth of M.I.T. so that it can hope to meet the challenges of a new generation in a new world.

Books

MAN'S WORLD OF SOUND, by John R. Pierce and Edward E. David, Jr.; Doubleday & Co., Inc. *Reviewed by Richard H. Bolt, Professor of Acoustics (Electrical Engineering) at M.I.T.*

IF THE neuter secretary—a machine that types out the letter you dictate—ever becomes a reality, its design will stem from many of the principles described in *Man's World of Sound*. This expertly unified account of speech, hearing, and language communication is at once a review of established facts and, to the imaginative reader, a preview of things to come.

Addressed to the informed layman, and any M.I.T. Alumnus qualifies, this book also gives the specialist in sound a useful picture of territories peripheral to his own. Whether he approaches his specialty as physicist, physiologist, linguist, musician, communication theorist, or electrical engineer, he will see here his own area nicely fitted into the whole map of man's interaction with sound. Topics include the elements of physical sound and vibration; the generation of sound by vocal chords, tongue, lips, and breath; the behavior of the ear in transducing sound energy into neuroelectrical signals; the information-processing functions of nerves and brain. Tonal quality and fidelity are examined, as is the meaning of hi-fi. More detailed descriptions are given of speech analysis and synthesis, of communication efficiency and speech compression, subjects in which the authors are highly expert.

Published in 1958, and thus written somewhat earlier, this volume unavoidably lags the swiftly advancing science at some points. To name just one: the given relation between loudness (sones) and loudness level (phones) does not reflect the latest findings. But the specialist knows that, and the layman or the scientist in another area can have the fun of finding it out himself if he follows some of the clues to relevant literature given in the book.

The Institute's share in advancing this field shows in numerous references to scientists who have studied and done research here. Indeed, the unifying concept of the book—the role of speech and hearing in language as the common mode of human communication—". . . the authors owe largely to Dr. Morris Halle, associate professor of linguistics." Mr. Pierce is a member of the Class of 1952, and Mr. David, the Class of 1947.

Few books better convey the essence of a science to the "average voter," the man whose informed backing is all important if we, as a democracy, are going to flourish in scientific research as we must. ". . . what we need in this country is science *fans*, just as we need baseball fans, football fans. . . . But to be a good fan one must have a good deal of knowledge beyond his own experience. . . . He must know how difficult it was to do."

Read it, and cheer the next advance in sound.

HOW OLD IS THE EARTH? by Patrick M. Hurley; Doubleday & Co., Inc. *Reviewed by Paul L. Lyons, President of the American Geological Institute and Chief Geophysicist of the Sinclair Oil & Gas Company.*

NO FACET of science is today being investigated with more activity and interest than the dating of rocks using radioactivity. The rewards to come in knowledge of the earth's chronology and in practical usage are great. Our resources come from the earth; the earth we must know. Patrick M. Hurley, '40, in his explanatory book *How Old Is the Earth?* shows a keen appreciation and a rare understanding of the scientific detective work which is now being ingeniously applied to extend our history billions of years into what is now the less dim past. The book should be fascinating and readable to anyone with enough scientific curiosity about the earth to want to know the answer to the title.

To the scientist, it is a most amazing fact that, as Dr. Hurley puts it, there are little grains of minerals in such rocks as granite, each of which is a minute clock capable of telling the exact time since the formation of the grain. To quote him again, let us not fear radioactivity, but use it to our advantage. His book is a lucid exposition of the uses of radioactive dating methods which have led to a recent tremendous advance in our knowledge of the earth and the universe. The clock minerals have been well selected, and by now many checks are possible on age determinations. Two methods are most generally the most useful, the Sr^{87}/Rb^{87} and the A^{40}/K^{40} ratios. The ratios determine the age of the containing mineral. In each case, the numerator of the ratio is the transformed radiogenic, or daughter, isotope, and the denominator is the radioactive isotope. The only assumption made is that the rate of breakdown of a radioactive substance has remained constant, or that time itself proceeds constantly.

In arriving at the answer to the question in the title, insight is gained into productive offshoots encountered in its pursuit. For example, it is possible to deduce that the radioactive elements are concentrated in the outer two of the seven shells of the earth, and that these elements have supplied most of the energy for the earth's great geologic events. Dr. Hurley, incidentally, thinks of the earth as an oxygen platform, for in truth it is mostly (60 per cent) oxygen. By contrast, the sun is a hydrogen platform, deriving its energy from high-temperature hydrogen reactions.

Ponder this statistic: At this instant the reader is being bombarded with 700,000 damaging radioactive bullets per minute, but he has a body capable of repairing the damage more rapidly than it is produced. He can take heart, too, from a fact well demonstrated by Dr. Hurley, that all the natural and man-made radiations responsible for this bombardment still amount to only one-fiftieth of the A.E.C.'s specified safety limits.

The reader will have some memorable dates to speculate about or benefit from. For example, the oldest rocks, found on all the continents, are nearly 2800 million years old. Do you want to find a gold mine? Curiously, most of the largest gold mines of

(Continued on page 52)

The married student's problems are varied. While studying for an S.M. in Civil Engineering, the U.S.I.A. reporter found, this young father was also a teaching assistant, an assistant to the lacrosse coach, a free-lance surveyor, and a traveling officer for his fraternity.

Can strong-minded individuals agree on any one goal? This was the question a graduate student and Professor Walt W. Rostow (right) were considering when the U.S.I.A. photographer and reporter visited the Center for International Studies.

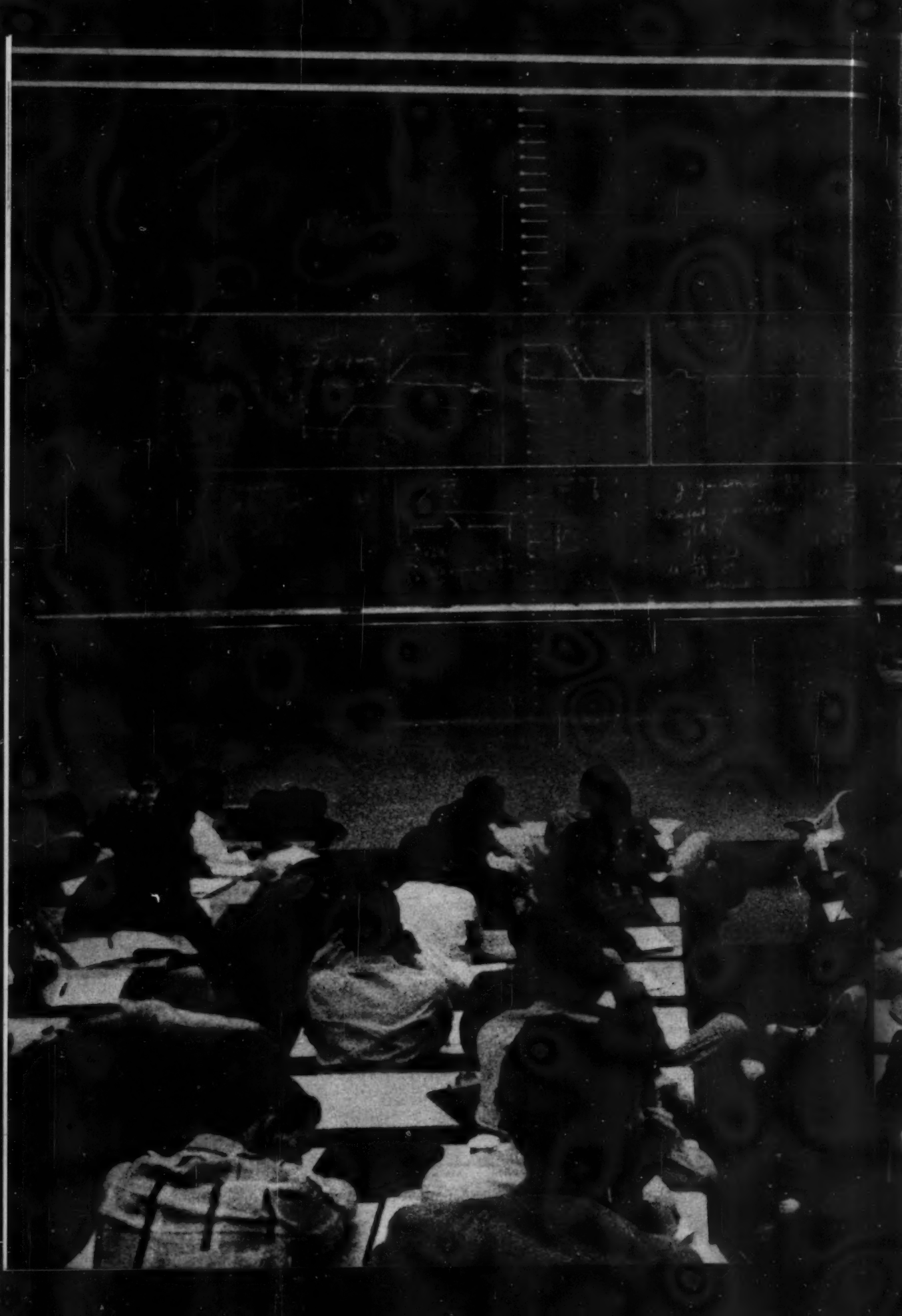
The drugstore on Massachusetts Avenue seemed strangely quiet, for a student rendezvous, to the U.S.I.A. reporter who had visited many other schools before preparing the picture report on M.I.T. that this government agency has sent overseas.

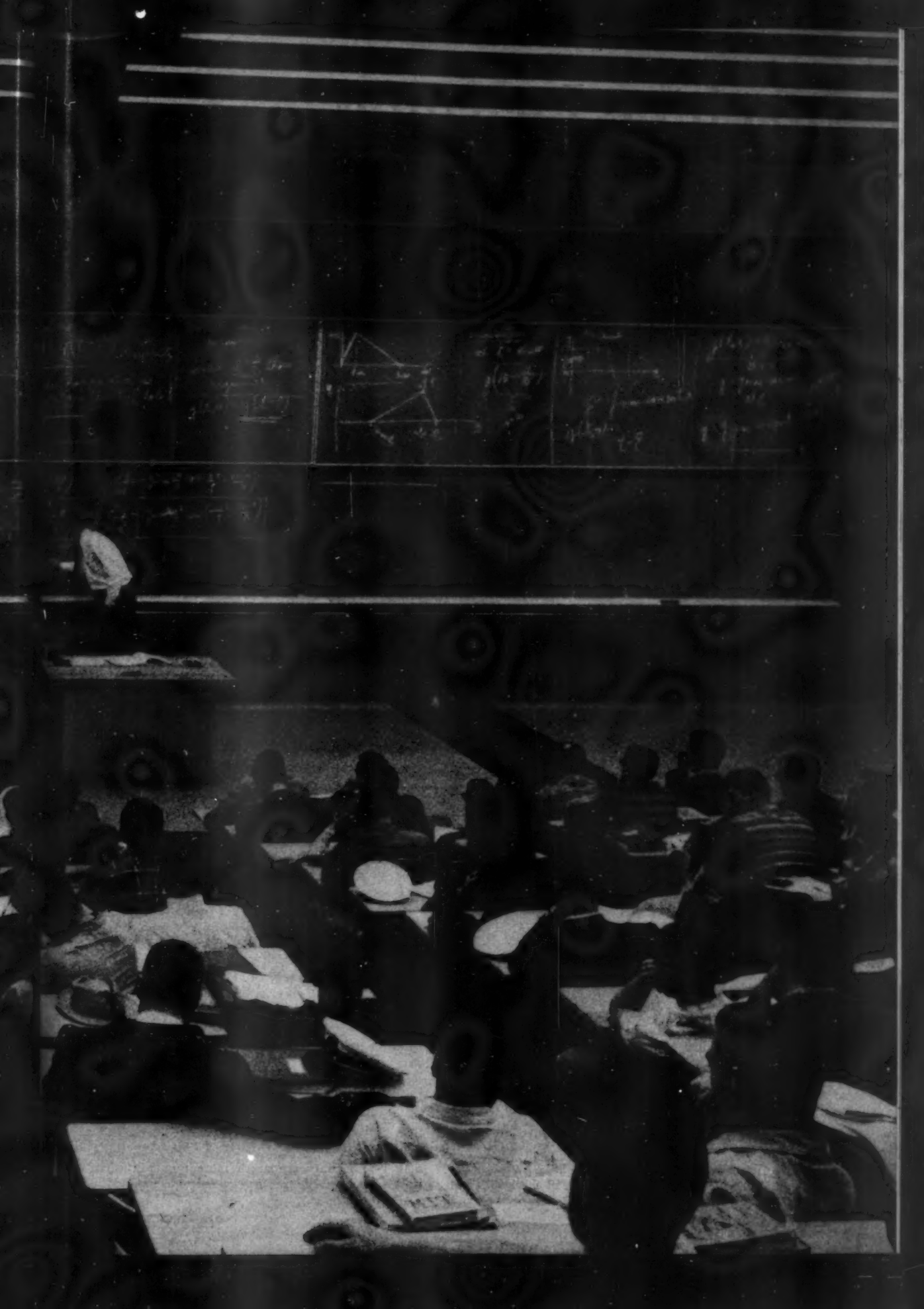
Freshmen and sophomores, 200 at a time, see the blackboards of the Compton Lecture Hall filled with equations, as shown in the photograph on the next two pages. Men in this class also work in laboratories and meet in small discussion groups.

As the World Sees Us

The United States Information Agency is sending these and other photos of "Shapers of the Future" to other lands

Photos by George Zimbel, taken at M.I.T. for a U.S.I.A. picture story for distribution overseas.





Machine Learning

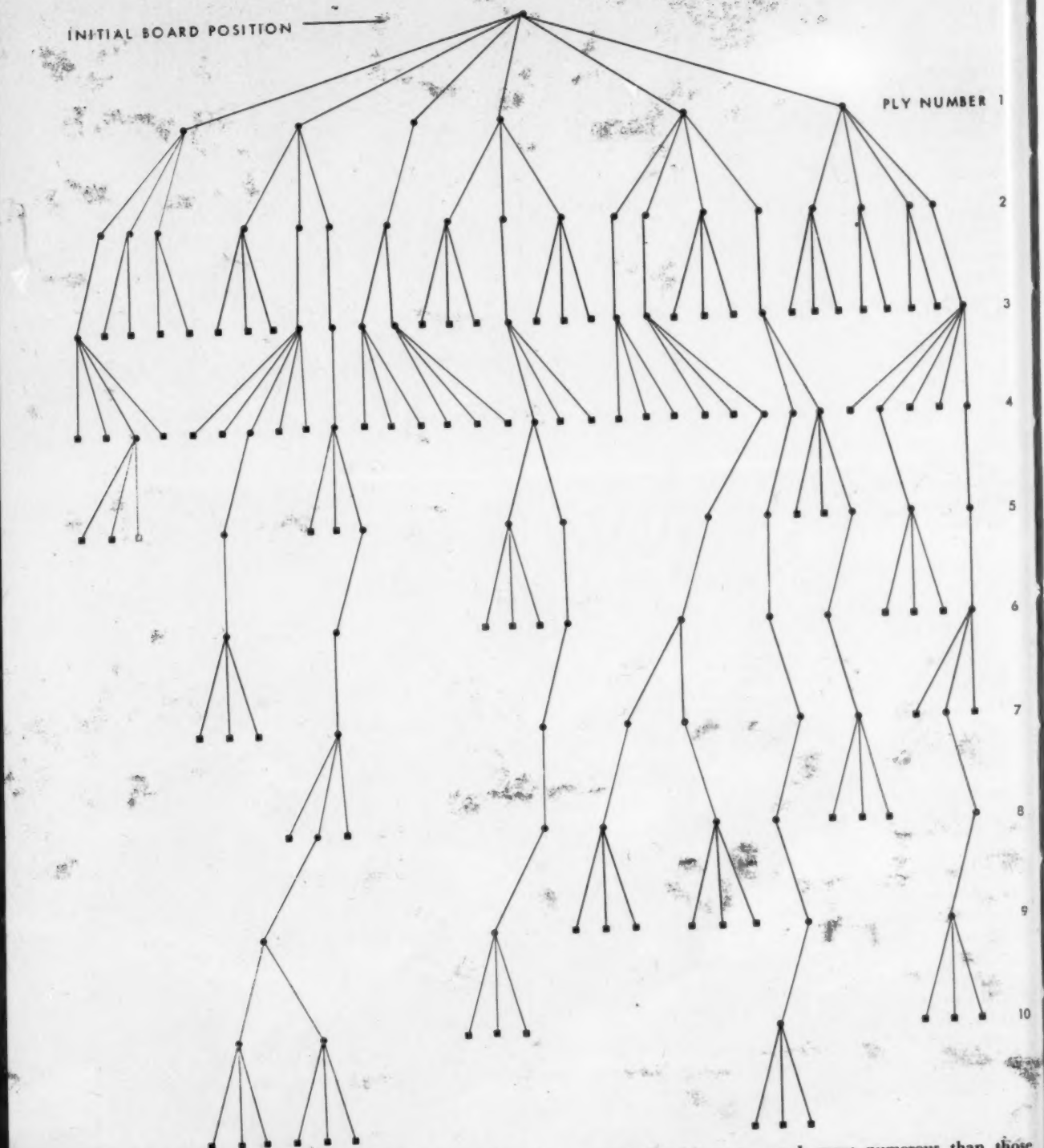


FIGURE 1: A "tree" of moves like this might be investigated during the look-ahead procedure in a game of checkers. The actual branchings are much more numerous than those shown here, and the tree may extend to as many as 20 levels.

Both rote and generalization learning have improved a computer's game of checkers . . . these techniques may be applicable eventually to problems faced in real life

BY ARTHUR L. SAMUEL

LEARNING is now being done by a machine. This statement may arouse all sorts of feelings—from complacent acceptance, perhaps coupled with the remark that "it's about time," to instinctive rejection of the entire idea on the basis that learning involves thinking, and thinking, by definition, is something that only man and the higher animals can do.

The fact remains that a digital computer (the IBM 704) has been programmed to play a competitive game of checkers, and to alter its method of play as a result of its experience in playing the game, and so to become a better and better player.* It is hard to describe this process without using the term *learning*. One can, of course, avoid all anthropomorphic implications by defining *learning* as the simple mechanistic process of profiting from experience. Alternatively, one can maintain that the computer is only achieving an end result which, if it had been achieved by a person, would have been the result of *learning*. The philosophically inclined reader will have to decide for himself whether or not this actually constitutes *learning*. To avoid circumlocutions we will use this term in referring to the computer, but, with the printer's co-operation, we will always write it in italics.

The Basic Checker Program

To understand how a digital computer *learns* to play checkers so well that it can beat the man who wrote the *learning* program, we first have to understand how it can be made to play legal checkers without any *learning*. The computer plays in very much the same way a human player does. This involves: (1) looking ahead several moves along all possible paths, the number of moves varying with the path and being limited by time considerations; (2) evaluating the resulting board positions in terms of material and positional advantages; and then (3) tracing back through the "tree" of anticipated moves for the most likely path consistent with the conflicting aims of the two players and so picking the best possible next move.

The look-ahead process is started by giving the machine a numerical representation of the initial positions of the checkers on the board. The computer then must be capable of computing all possible moves starting from these positions, of making any one of these moves, of computing the new board positions, which would result from the execution of this move, and of repeating this process. Board positions are stored in the machine as a series of *1's* and *0's* in specially assigned storage locations which correspond to the squares on the checkerboard; a *1* representing the presence of a piece on this square, and a *0* representing an unoccupied square. Different storage locations are, of course, used for the two sides and for men and kings. Listings of possible moves are indicated similarly by a series of *1's* in designated storage locations corresponding to the squares occupied by the pieces which can move, again with different storage locations used for moves which proceed in different directions along the checkerboard. The program causes the computer to make the necessary calculations to provide for the transformation from a board representation to a move representation, the selection of one move from the list, and the generation of a new board representation showing conditions after the move. This process is illustrated graphically in Fig. 1.

At the end of the look-ahead procedure, the program must make a numerical evaluation of the resulting board position, using either criteria supplied by the programmer, or criteria which a *learning* routine selects. This process is primarily one of counting; counting the number of pieces on the board, counting the number of squares to which each side can move, etc.

The third process is that of tracing backward through the "tree" of possible moves, the machine acting to maximize its own advantage, while the opponent is assumed to be trying to maximize his advantage and, hence, minimizing the machine's advantage. This logical process, sometimes called "minimaxing" is fairly simple to carry out, and it leads to the choice of one move which is computed to be the best move available to the machine. Figure 2 may help in visualizing this phase of the analysis.

The selected move is communicated to a human opponent (when the computer is not playing against itself) by lights on the console and by a printed record so that the corresponding move can be made on an external checkerboard. The person playing the machine transmits his reply to the computer by switches on the console. The computer verifies the legality of the reply and signals its acceptance by listing the move on the printer. The entire process then is repeated until the computer predicts a sure victory for itself or concedes.

For several years, Arthur L. Samuel, '25, of the IBM Research Center at Yorktown Heights, N.Y., has devoted spare time to teaching a computer to play checkers. He chose checkers because the simplicity of its rules enabled him to concentrate his attention on machine-learning techniques. The IBM 704 now can beat him, but still cannot beat a checker champion.

"I have been pressured to cheat a little, and depart from my rule that the program must never be given any more information than is absolutely necessary," he told The Review's editor while he was working on this article. "It would be relatively easy to store a certain amount of checker lore and make the program play a better game, but I have stuck to my resolution."

The New Yorker *recently called Dr. Samuel "one of the best of the old-fashioned brains in the IBM research department."*

*A. L. Samuel, "Some Studies in Machine Learning Using the Game of Checkers," *IBM Journal of Research and Development*, 3: 211-229, No. 3 (July, 1959). Figures 1, 2, and 3 were reproduced from this publication.

Using this basic program as a tool, two different *learning* techniques have been investigated in some detail. One of these is a simple extension of *rote learning*, in which a record is kept of board-position evaluations as they are made so that they can be referred to in later games. The second technique involves a rudimentary form of *generalization learning* in which the principles used to evaluate board positions are continually altered as a result of experience, and only these modified general principles are saved.

Rote Learning

One might argue that merely saving the results of previous moves would not cause the computer to play better with time, because previous moves, whether good or bad, simply would be repeated. Fortunately, a procedure is available to avoid this. It involves giving the computer the ability to utilize stored information in a different context from that in which it was obtained.

To make this procedure understandable, consider a simple case in which the program looks ahead, perhaps for three moves (called a ply of three, as shown in Figure 3), before attempting to evaluate the resulting board positions. The program then refers to the list of saved board positions. These saved board positions have with them scores which themselves were the result of a minimaxing procedure. Whenever one of these saved board positions is encountered again the program can take advantage of its previous look-ahead and, in effect, look six moves in advance rather than three. To the extent that the backed-up score is better than an equivalent directly computed score, the program will be able to choose a better move than it might otherwise have made. The new initial board position with its six-ply score, in turn, is saved; it may be encountered in a future game and the score backed up by an additional set of three levels. The exploitation of this simple technique causes the program to *learn* and, surprisingly enough, it is a fairly powerful *learning* scheme.

Several additional features were required to produce a satisfactory *learning* program. We have space to discuss but one of these: the one having to do with a sense of direction which must be imparted to the program to cause it to press on toward a win. To illustrate the need for this, consider the special situation of two kings against one, which is a winning combination for practically all variations in piece arrangements. In time, the program can be assumed to have stored all of these board positions, each with a winning score. Then, if such a situation is encountered, there is no basis for a decision, since the program looks ahead along all possible paths and most of these paths lead to winning positions, even though only one of the possible initial moves is along the direct path toward the win, and all the rest are time-wasting. This dilemma is avoided by keeping a record of the "ply value" of each backed-up score and by arranging for the program to choose between board positions having equal scores on the basis of "ply" so that it will press toward a win if it is ahead and adopt delaying tactics if it is behind.

Although this *rote-learning* technique seems simple in concept, it was able to improve the game-playing ability of the computer to a very significant degree in a surprisingly short time — at least for the opening and end-game portions of the play. To improve the mid-game play significantly would have required an exorbitant amount of playing time, in view of computer rental costs, although this time probably would not be as long as that which a checker master spends acquiring his proficiency.

Generalization Learning

An alternate *learning* scheme which required much less storage also has been investigated. This scheme involves the formation of certain generalizations on the basis of the *learning* experience. The program selects a subset of parameters from a list of possible parameters (supplied by the programmer) which are found to be of value in evaluating the desirability of board positions, and assigns numerical coefficients to be used with these to form the terms of an evaluation

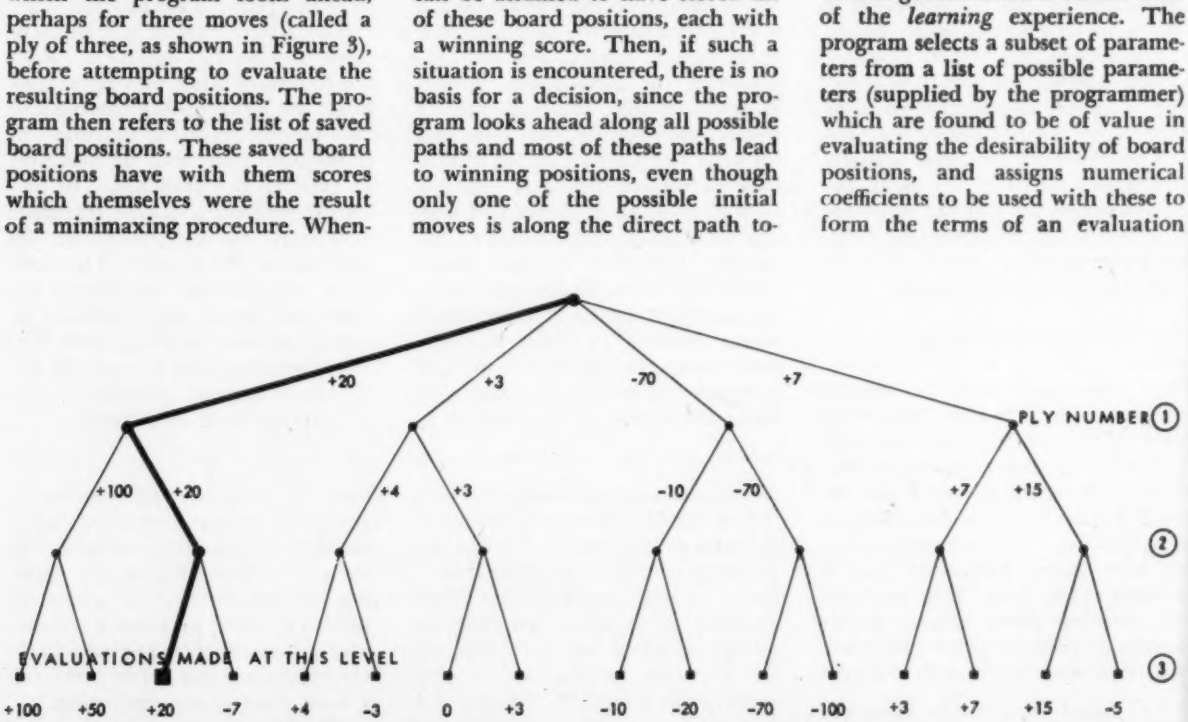


FIGURE 2: Simplified diagram shows how evaluations are backed-up through the "tree" of possible moves in a checker game to arrive at the best next move. The evaluation starts at 3; at 1, the machine chooses the branch with largest score; at 2, the opponent is expected to choose branch with smallest score; at 3, machine chooses one with most positive score.

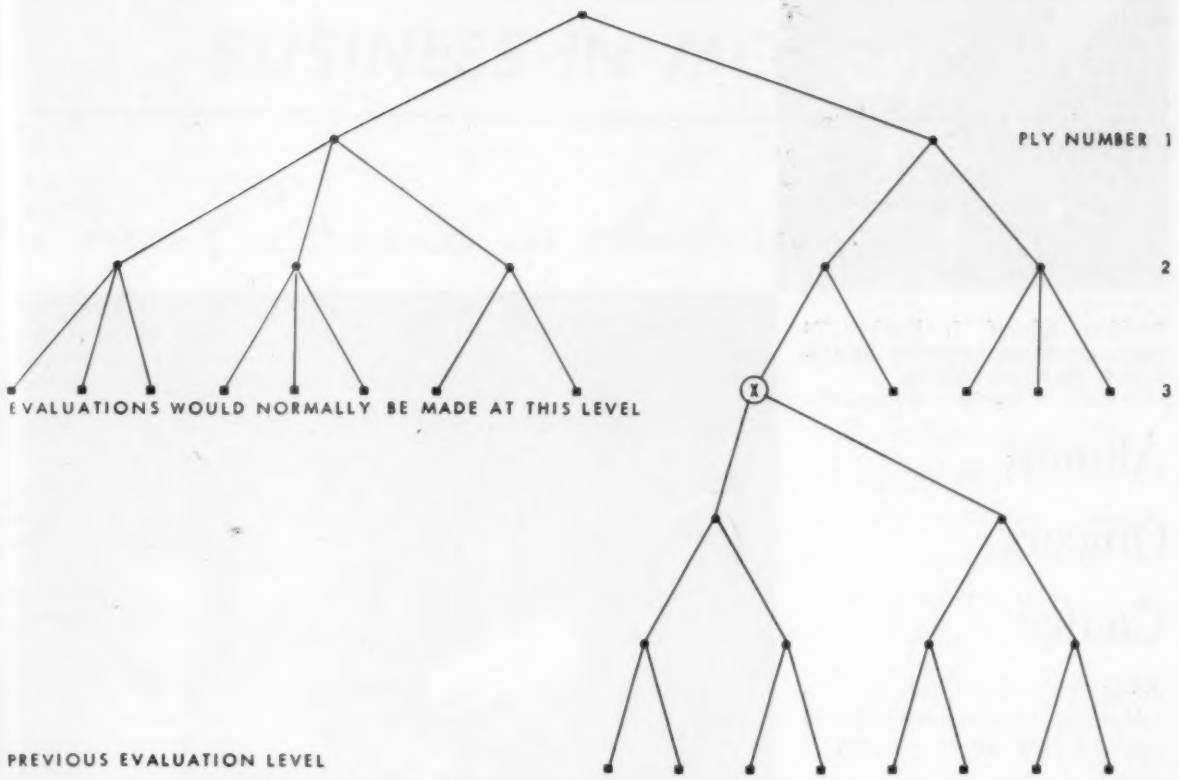


FIGURE 3: Simplified representation of the rote-learning process, in which information saved from a previous checker game is used to increase the effective ply of the backed-up score. The X indicates a typical board position found in the computer's memory with the score from a previous look-ahead. This technique improved the game significantly.

polynomial. This is the polynomial that is used to evaluate board positions at the terminals of the look-ahead process.

If the program is to make changes in its scoring polynomial it must be given some trustworthy criteria for measuring performance. In spite of the apparent bootstrap nature of the operation, it is possible to use this same scoring polynomial to measure progress. When the program finds that the computer is gaining in strength as the result of a series of moves — and this is observed by comparing the scoring polynomial computed for an initial board position with that computed for a board at the end of this series — adjustments are made in the coefficients on the theory that those terms which contributed positively to the initial polynomial should have had larger coefficients, while those which contributed negatively should have had smaller coefficients. Adjustments in the reverse direction are made if the computer appears to be losing ground.

To complete the *learning* process the program is arranged to discard those terms which consistently have the lowest absolute-value coefficients and to replace them with new terms taken from the list supplied by the programmer. With time, then, the program selects the 16 most important parameters from the list and ranks them in importance by assigning numerical values to their coefficients.

This *generalization-learning* scheme was found to be particularly successful in improving methods of play during the mid-game when, it will be recalled, the *rote-learning* scheme was less useful. It was not nearly so effective during the beginning and end-game play, where circumstances seem to call for highly specialized forms of play which can be *learned* better by rote.

Conclusions

The *learning* techniques studied in these checker experiments require reprogramming for each new application. They are, however, very efficient both in terms of equipment requirements and in terms of speed and, as has been demonstrated, they are capable of realization at the present time. This general approach can be contrasted with a second procedure, sometimes called the Neural-Net Approach, which attempts to induce *learned* behavior into a randomly connected switching net (or its simulation on a digital computer) as a result of a general reward-and-punishment routine. This second approach ultimately may prove to be the more important one, since, in principle, it leads to a device which can *learn* anything, but for the present it is still in the speculative stage. Enough has been done using the first approach to demonstrate that it is now possible to devise *learning* schemes which will greatly outperform the average person, and it eventually may be economically feasible to apply such *learning* schemes to real-life problems — as well as such pastimes as checkers.

President Edward J. Hanley, '24 (right), presented a gavel to John J. Wilson, '29, his predecessor.

Alumni Officers Confer

President Stratton speaks in Cambridge and Chicago, and eight men receive bronze beaver citations.

How the Institute is "moving in the mid-stream of great events" (the words are President Stratton's) was shown to 350 leaders in Class, Club, Alumni, and Educational Council work who met in Cambridge in September, and 70 more in Chicago in October. At both sessions of this third annual Alumni Officers' Conference, President Stratton spoke on current problems and plans of the Institute, and declared that it must become as well known for research in education as it is for research in other areas.

Edward J. Hanley, '24, President of the Alumni Association, opened both gatherings by reviewing the many

(*Concluded on page 60*)

John Kilduff, '18, was one of eight Alumni to whom bronze beaver citations were given at the third annual conference of Alumni Officers.

More than 15,000 Class Agent letters were signed by Alumni who attended the two-day Cambridge meeting.

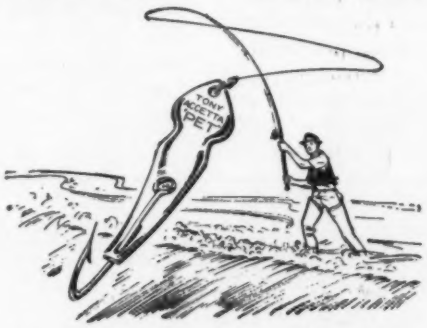
Equipment used to enable a girl to take the place of a chainman interested Alumni who heard lecture by Chas. L. Miller, '51, in Cambridge.

BUSINESS IN MOTION

To our Colleagues in American Business . . .

Wham! And the fisherman hooks another record-breaker on the lure you see below. Just as that smart angler knew how to successfully fish that "Pet" Spoon bait so did the maker who designed and perfected it know exactly where to go in search of the brass from which to make that lure.

In order to produce the finest quality bait at a competitive price, he knew that he required a metal that could be easily stamped and formed, and of such quality and uniformity of grain structure that only the minimum of finishing would be required prior to the chromium plating of the lure.



Past experience had proved to this artificial bait manufacturer that, of the various commercial metals available, brass was the metal to use for this lure. For brass is easily stamped and formed . . . has just the right "heft" for casting, does not rust and it takes chromium plating as a fish takes to water. But when it came to selecting the exact type of brass that would best fit his exacting requirements, he called on Revere.

The result was a Revere Brass with special grain size and finish, and just the right ductility so that even after stamping and forming only a minimum of work is required prior to chromium plating.

Said the manufacturer, "Without a doubt, the fine quality of Revere Brass has contributed immeasurably to the quality of our baits, at the same time saving us money on forming and finishing cost. In fact, it is the quality of the material, plus design and workmanship that has made it possible for us to be awarded the Medal of Honor by the Sportsman's Club of America for the superiority of design and fish-getting ability of our baits, as well as the National Sportsman's Research Award, which is a real tribute to the design, workmanship and effectiveness of our lures."

The experience of this manufacturer, once more illustrates how, only by working closely with your supplier are you able to realize the highest return per dollar spent. That, too, is why it may very well pay you to let Revere help you "fit the metal to the job." Others have profited by this service, why don't you take advantage of it?

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Talk of Our Times

Atomic Power in Other Lands

Robert E. Wilson, '16, spoke at the World Petroleum Congress in New York last summer about "The Probable Impact of Atomic Energy on the World Petroleum Industry." Mr. Wilson is retired Chairman of the Board of the Standard Oil Company (Indiana), a member of the General Advisory Committee to the Atomic Energy Commission and a member of the M.I.T. Corporation.

After defining commercial use of atomic energy, and discussing the prospects in this country, particularly as they bear on the future of the oil industry, Mr. Wilson turned to the situation overseas. In this portion of his address, he challenged some widely held ideas. Speaking of the prospects for commercial use of atomic energy in other lands, Mr. Wilson said in part:

POSSIBLY the most important popular misconception is that nuclear power offers great promise to lift the underdeveloped countries quickly out of the difficulties which result from an inadequate power supply. While there are differences between these countries in the cost and availability of oil, gas, and water power, as well as in other factors, in general the underdeveloped countries will be among the *last* to be able to employ nuclear power to good advantage. This is due to a combination of reasons.

In the first place, nuclear power, to come close to being competitive with conventional power, needs to be installed in large units, with high load factors and without having to incur the heavy costs and losses of long-distance transmission. This is, of course, due to the high capital investment involved in nuclear plants, and the fact that this cost per unit of output drops rather rapidly with increasing size. A country like England, which has a well-developed, high-density power transmission grid, can much more readily integrate into the system a number of large units to handle the base load, and operate them with a load factor of 75 to 80 per cent. Most of the underdeveloped countries, on the other hand, really need power plants of relatively modest size at scattered locations, and can scarcely expect to have a high load factor for many years.

Furthermore, even if nuclear power were close to being competitive under the circumstances prevailing in these countries, the high investment cost — at least twice that of conventional plants of similar size — means that underdeveloped countries would have better use for their limited capital in other fields and would prefer to pay slightly higher direct operating costs. They could not justify, even for government-owned facilities, as low total charges for capital as the 9 per cent which England currently figures for interest plus depreciation — apparently they include nothing for local taxes or insurance.

(Concluded on page 50)

THESE R&D PROJECTS FOR FUTURE DECADES IN SPACE

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New programs under development at Lockheed's California Division are planned to solve America's future exploration projects into space. The new multimillion-dollar Research Center in nearby San Gabriel mountains is further evidence of Lockheed's determination to support and supplement its already extensive research and development activities.

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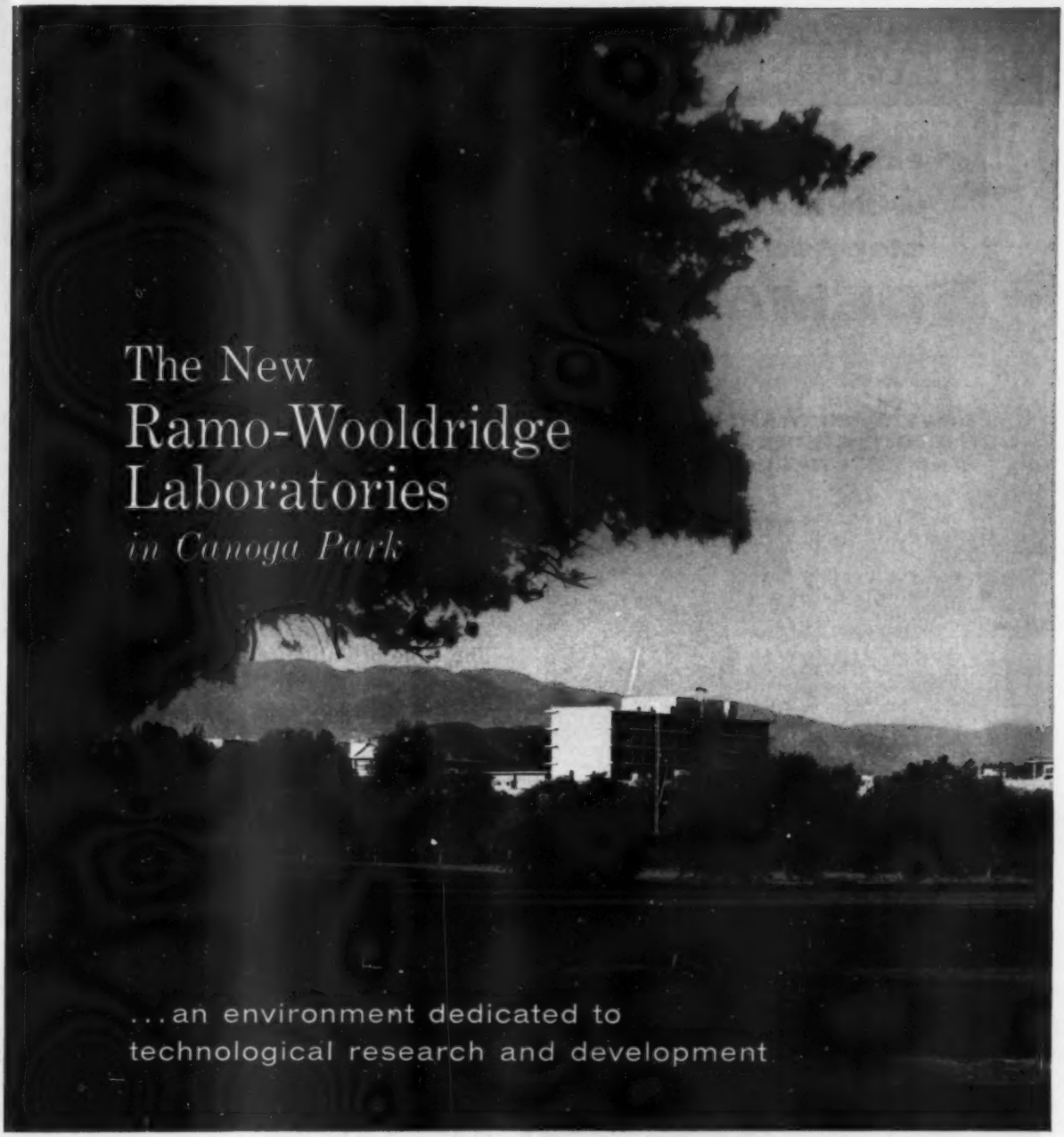

The new Ramo-Wooldridge Laboratories in Canoga Park, California, will provide an excellent environment for scientists and engineers engaged in technological research and development. Because of the high degree of scientific and engineering effort involved in Ramo-Wooldridge programs, technically trained people are assigned a more dominant role in the management of the organization than is customary.

The ninety-acre landscaped site, with modern buildings grouped around a central mall, contributes to the academic environment necessary for creative work. The new Laboratories will be the West Coast headquarters of Thompson Ramo Wooldridge Inc. as well as house the Ramo-Wooldridge division of TRW.

The Ramo-Wooldridge Laboratories are engaged in the broad fields of electronic systems technology, computers, and data processing. Outstanding opportunities exist for scientists and engineers.

For specific information on current openings write to Mr. D. L. Pyke.

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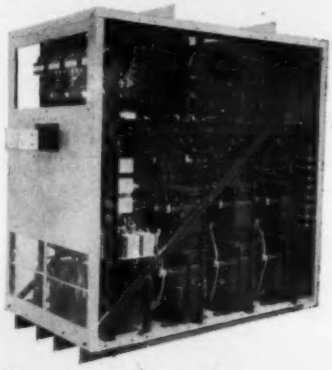
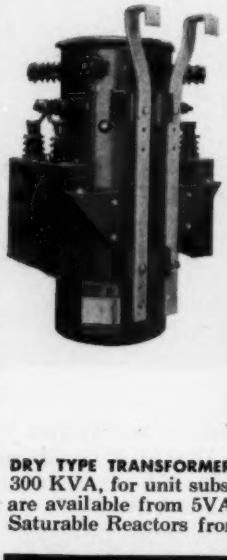
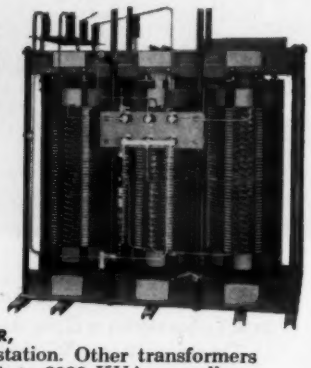
DRY TYPE TRANSFORMERS,
CONSTANT CURRENT REGULATORS
AND SATURABLE REACTORS



CONSTANT CURRENT REGULATOR used in an industrial electrochemical process.



CONSTANT CURRENT REGULATOR for street, subway and airport lighting.



DRY TYPE TRANSFORMER, 300 KVA, for unit substation. Other transformers are available from 5VA to 2000 KVA as well as Saturable Reactors from 25VA to 500 KVA.

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Harold E. Koch, '22, *President*
Elton E. Staples, '26, *Vice President*
Chester Meyer, '36, *Assistant Secretary*

Talk of Our Times

(Concluded from page 48)

Another difficulty facing underdeveloped countries is the absence of domestic plants for the manufacture and maintenance of the large amount of special equipment and supplies needed by nuclear plants, and of facilities for reworking spent fuel elements, handling waste disposal, etc. Still another would be the difficulty in many countries of getting the trained personnel necessary for safe operation.

Sad as it may seem, economics would therefore indicate that nuclear power will probably make much more rapid progress in industrialized countries with high power requirements, and would of itself tend to *widen* the gap between countries, rather than serve as the "great equalizer" which some have hoped. . .

In general, it would seem likely that in England and possibly one or two other countries of western Europe atomic power plants will become competitive some five years earlier than in the United States, but that they will not replace any existing plants of reasonable size and age. In the rest of Europe, I would expect that the time when atomic power would become competitive would be similar to that for the higher-cost areas in the United States.

The Role of Athletics

(Concluded from page 32)

The Armory already has become a popular gathering place for the Institute Community during the winter months. The skating rink, built in 1954, has brought Faculty and students together increasingly, and enhanced interest in physical education. The new 10-lap cinder track around the inside perimeter of the Rockwell Cage will preclude the necessity for track team enthusiasts to compete in 25-degree temperatures during the indoor season. The expansion of the playing fields will permit more teams to engage in intramural competition.

The Alumni Pool has continued to be a center of interest for both the Faculty and students. This summer it was used by sons and daughters of the Faculty and Alumni, and new programs in elementary diving and life-saving have been provided to meet student requests. The new squash courts in the Du Pont Athletic Center will be a partial answer to the crowd waiting to use those at the pool.

"This whole extracurricular part of a student's life must be integrated into the plan of education itself," President Stratton has said, and this will be facilitated by the new center. Completed now, despite 10 strikes in the course of its construction, these new quarters have enabled the Athletic Department to begin a new period of development this year.

I hope that we will continue to encourage each student at M.I.T. to explore the depths of his individual ability in everything he undertakes. Our goal is to effectively refute the "cult of easiness" in which a large segment of our society has nurtured the idols of security, conformity, and comfort, both in the classrooms and on the athletic fields. By such an effort, I feel, M.I.T. can help to fulfill the obligations of providing leadership throughout the world.

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Books

(Continued from page 38)

the world occur in rocks this old. The gold came before life; the oldest fossil life, from the radioactive age of the enclosing rocks, is 1600 million years old. Oddly, the time record from 1600 million years ago to 700 million years ago is still almost a blank and should be filled in, if possible. At 700 million years, the fossil record starts to be complete. But in 85 per cent of the earth's history, recognizable fossils in the rocks do not exist. Another surprise is that the great ice age is only 10,000 years behind us; this answer is the product of the carbon-14 dating technique which is well explained by Dr. Hurley.

What about man? Well, Pithecanthropus originated about 200,000 years ago, and has descended through 4000 generations. Poor old Neanderthal man became extinct about 50,000 years ago. Man-apes started to use fire 250,000 years ago.

The study of radioactivity has, of course, resulted in an understanding of the sun, now known to be a youthful star working on hydrogen. The ultimate age of the earth is bound up in the future of the sun; it appears that the sun will, in some billions of years, be reduced to working on the heavier elements created by that time, and it will become 1000 times more luminous and have a radius 100 times greater than at present, all of which will be hard on the earth. What of its age? The sun cannot be older than the galaxy universe of which it is a member. That age, by extrapolation backwards of the well known lead and uranium association, is about 5 to 7 billion years.

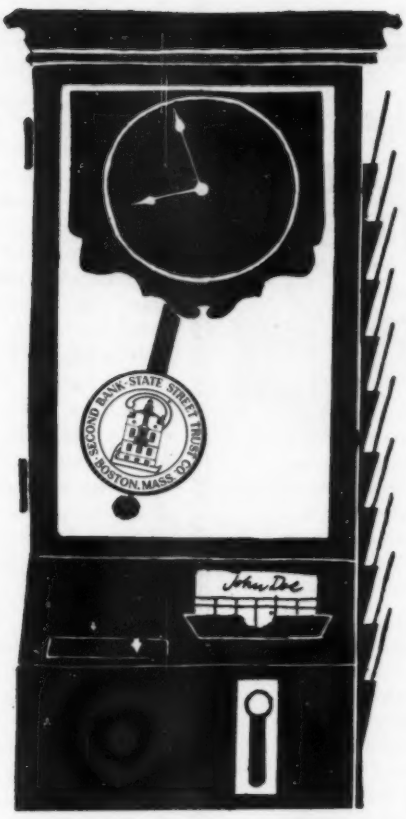
Finally, just how old is the earth? In the last century, Lord Kelvin, neglecting radioactivity, estimated from thermodynamics that this terrestrial ball is only 24 million years old. Dr. Hurley explains that radioactivity, the true source of the heat flow used by Kelvin, indicates its age to be 4.5 billion years. Everyone with a sense of history should read the account of the fascinating research behind the derivation of this value.

As Dr. Hurley concludes: "How majestic are these broad reaches of time! . . . the true reward is not to be found in whether our calculations are correct, give or take a few million years; it lies in the discoveries, in the advancement of human knowledge and philosophy that are the inevitable products of scientific search for law in nature."

WHAT MAKES A SCIENTIST, by George Waltz; Doubleday & Co., Inc. *Reviewed by William Speer, Associate Dean for Student Counseling at M.I.T.*

THE body of this book consists of a dozen biographical sketches of living scientists. At least four of them are familiar names to M.I.T. Alumni: Dr. Bush ['16], Professors Zacharias and Shannon ['40], and Josiah Macy, Jr., '49. Among the others are two Nobel Prize winners, Dr. Selman A. Waksman of Rutgers and Dr. Edward M. Purcell of Harvard, and a half dozen other men now famous for their work in various fields. Even the most unscientific reader cannot fail to see

(Continued on page 54)



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Books

(Continued from page 52)

how the sciences no longer can be considered as separate areas, and will appreciate why Dr. Macy refers to himself as a mathematical biophysicist.

The title is somewhat misleading, if the reader is expecting an inquiry into the mysteries of creative thinking. In the introductory chapter the author states that his purpose is to dispel the image of a scientist as a "long-haired individual in unpressed clothes, with a far-away, absent-minded look in his eyes, and with perhaps a beard covering a rumpled collar and an askew tie—a man who is uninteresting, underpaid, and unhappy." In its place he would like to substitute the image of men who are "little different basically from the average successful professional man." He quotes a nuclear scientist who said, when speaking about himself and his fellow scientists, "We're all rather revoltingly normal."

In achieving this purpose, the author has in some ways been more successful than he intended. The individuality of his subjects is blurred by the uniformity of his style, which chronicles events rather than attempting to analyze or interpret them. Difficulties and obstacles are mentioned, but the reader is in danger of being lulled into an acceptance of some automatic element in each man's rise to eminence. In these days when excellence is in danger of becoming a catchword in educational circles, we need to be reminded of the thought expressed by an early Greek poet when he said: "Before the gates of excellence the gods have placed sweat. Long is the road thereto and rough and steep."

Mr. Waltz's book will be of greatest value to the boy in his early teens, and to the father looking for a birthday present who finds little to choose from in the field of scientific biography. There are good classical biographies of some of the giants of earlier generations, but few, if any, of men now living. This book begins to fill the gap. Many, if not all, the men in it can be included in a boy's gallery of heroes without fear that they will suffer by comparison with the more conventional objects of hero worship. This is the book's very real contribution.

It includes eight pages of photographs.

ECHOES OF BATS AND MEN, by Donald R. Griffin; Doubleday & Co., Inc. *Reviewed by Paul Cohen, '35, of the Sperry Gyroscope Company.*

DR. GRIFFIN, who is professor of zoology at Harvard, has been a pioneer in the determination of how animals, particularly bats, find their food and move through the dark by listening to the echoes of the sophisticated sounds which they themselves produce. The field is important not only for its own intrinsic interest, but also because of the light it sheds on man's efforts to find his way by sound in the ocean depths, and on means of guidance for the blind.

Although the book, as one of the Science Study Series, is a text capable of serving the needs of high school students, its simplicity disguises an encyclo-

(Concluded on page 56)

. . . tile or toothpaste

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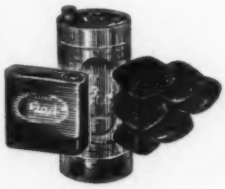

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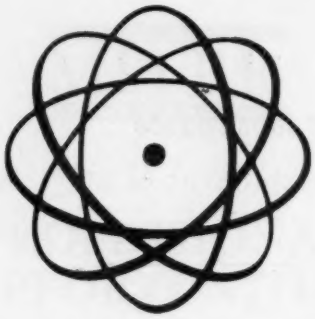

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Books

(Concluded from page 54)

pedic background. Griffin's earlier book, *Listening in the Dark*, is suggested as a more formal and quantitative examination of the subject.

A porpoise, caged in a small pond of dark and murky water, can find a six-inch fish with a succession of short, high-pitched pulses, which to a human observer sound like the creaking of a door. What's more, it can distinguish this little fish, which is not a good reflector of sound, from the multitude of echoes coming from the bottom of the pond, its banks, the boat in which the observers sat, and the entire background of rocks and aquatic plants. Porpoises, incidentally, can hear sounds as high as 150,000 cycles per second. Humans, in their prime early years, can do little better than 15,000 cycles.

Bats also operate at frequencies far above human bearing. In fact, for most species, 99.9 per cent of the sound energy they emit is ultrasonic, which is why their method of echo location remained undetermined until Griffin borrowed some electronic apparatus from a Harvard physics laboratory. Many species of bats habitually capture flying insects smaller than a gnat with a much more refined "sonar" system than that by which destroyers attempt to track submarines. These bats emit pulses possessing the most advanced features known to our radar and sonar experts (frequency modulation, variable repetition rate, variable pulse length) and then proceed to process the returning echo with techniques which human engineers cannot understand, let alone equal. This with a brain the size of the eraser on a pencil.

By the extreme gain of their echo-location system, bats can almost defy the laws of physics, being able to locate and avoid fine wires much smaller in diameter than a wave length of the sound they are emitting. Perhaps a still more amazing feat is the ability of some bats, flying just above a smooth water surface, to detect completely submerged minnows. Because sound is, to a small fraction of 1 per cent, reflected when striking such a sharp interface as a water-air surface, the amount of energy making the round trips from bat to fish and back to bat, is, Dr. Griffin estimates, barely one part in a million* of the emitted chirp. But the bats get their fish.

*It has been suggested that when the fish's air bladder is less than half a wave length from the surface, the bat's problem may be somewhat easier than this ratio implies.

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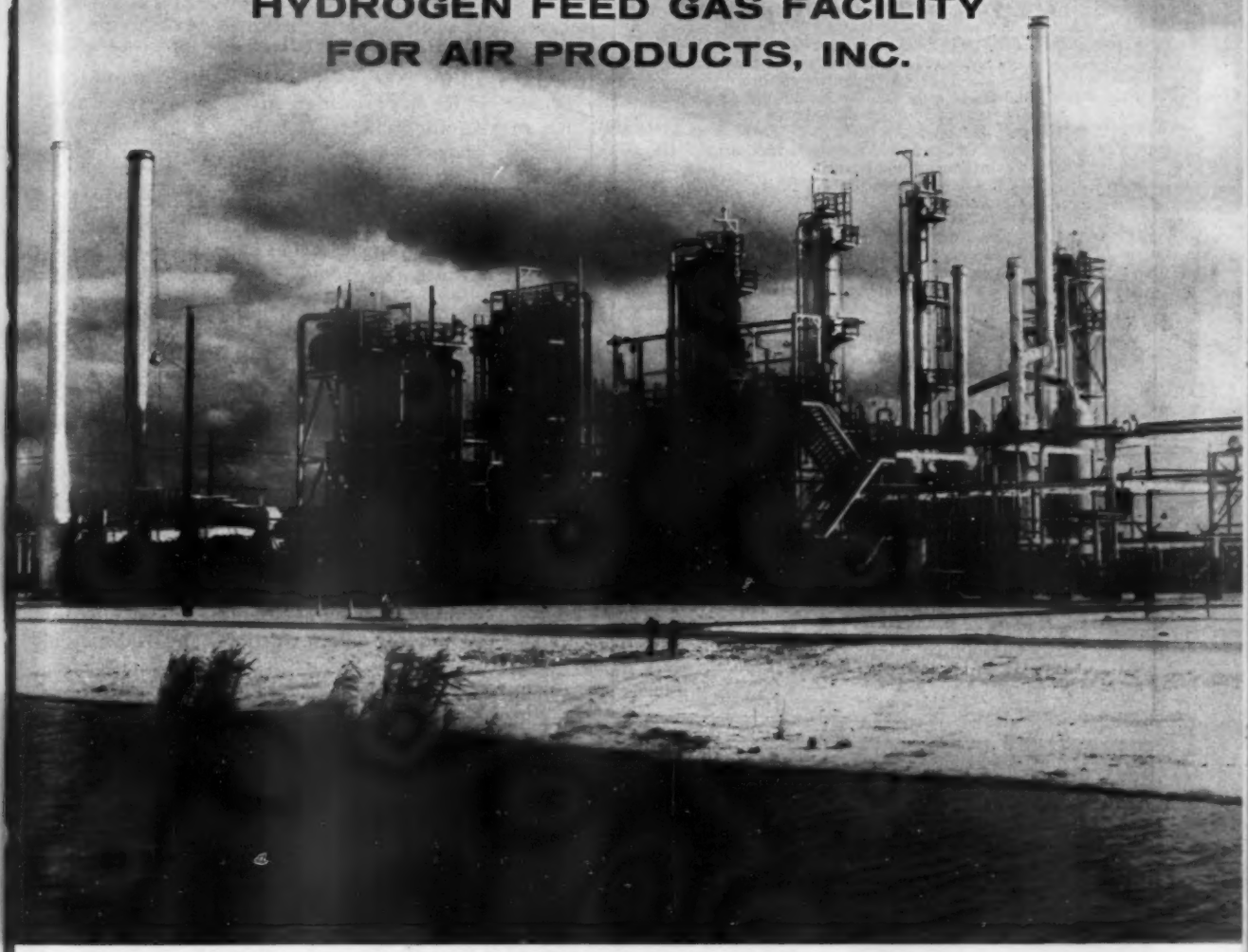

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Trend of Affairs

(Concluded from page 25)

The Growth of Humanities

THE Institute's School of Humanities and Social Science, which has grown greatly in recent years, now has an Assistant Dean. He is Arthur L. Singer, Jr., who for four years has been Administrative Officer for the Center for International Studies.

Dean John E. Burchard, '23, pointed out when Mr. Singer's appointment was announced that in the last decade the staff of the School of Humanities and Social Science has increased from 75 to 107, and the number of full professors from 10 to 31. There also has been a substantial increase in the range of the school's interests, both in subjects offered and in research conducted.

"To economics and industrial relations, we have added political science, psychology and certain kinds of sociology," Dean Burchard went on. "We have increased the work given in history, literature and music, and have added substantially to that in philosophy and the history of science.

"To the fairly elementary work in modern languages we have added courses in the literature, a section of the core curriculum taught exclusively in French, a new emphasis on the Russian language, and the teaching of semantics and linguistics. The school now has about 150 undergraduate majors and substantial doctoral programs in economics and political science. An increasing number of M.I.T. students elect subjects in the humanities over and above the eight subjects required for a degree."

Mr. Singer, who is 30 years old, will assist Dean Burchard in a variety of ways, with emphasis on matters relating to the social sciences and the Dean's responsibilities as chairman of the board of The Technology Press. He also will continue as a member of the senior staff of the Center for International Studies.

He was graduated from Williams College in 1950 with an A.B. *cum laude* in economics, and received the M.B.A. with distinction from the University of Michigan. He was assistant to the executive officer of the *U.S.S. Franklin D. Roosevelt*, and combat information center officer on the *U.S.S. Worcester*, while in the Navy, and was briefly an assistant in business research at the University of Michigan in 1952.

Tunnel-Diode Puzzle Solved

JEROME J. TIEMANN, '53, is one of the men at the General Electric Research Laboratory in Schenectady who are credited with explaining puzzling wiggles in the performance curves of tunnel diodes. These are very new first cousins to transistors, although they operate on a different principle. The explanation of their performance may accelerate development of tunnel diodes for use in high-speed computers, television sets, space vehicles, and communication equipment.

A tunnel diode is smaller than a transistor, simpler in structure, and less affected by radiation. It can be used as an amplifier, a generator of radio-frequency power, or a switching device. In the latter role, the tunnel diode has functioned 10 to 100 times as fast as the fastest transistor.

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Alumni Officers Confer

(Concluded from page 46)

ways in which Alumni are assisting the Institute. Edwin D. Ryer, '20, chairman of the Alumni Fund Board, reported that the Fund last year totaled $575,000 and had more than 15,000 contributors.

Bronze beaver citations were given to:

Thomas K. Meloy, '17, whose "personal and untiring efforts were, in large part, responsible for the success of the Washington Regional Conference of March, 1958."

John W. Kilduff, '18, "President of his Class and Chairman of the Newburyport Region in the Alumni Fund which for the past two years, he had led to a perfect 100 per cent participation."

Eugene R. Smoley, '19, "Secretary of his Class; Past President of the M.I.T. Club of New York; Past Regional Chairman for Scarsdale in the Alumni Fund; but primarily because, as Reunion Gift Chairman, he led his Class in making the first 40-year gift a very substantial one."

Philip L. Coleman, '23, "Past President of the Chicago Club; Special Gifts Metropolitan Area Chairman for his Class; and long-time Regional Chairman and Educational Counselor whose thorough and conscientious reports throughout the years have been of great assistance in determining the qualifications of a great many prospective students."

F. Leroy Foster, '25, "Chairman of this Third Alumni Officers' Conference; but primarily because, as Secretary of his Class, his highly readable notes in The Review have always been models of concise and newsworthy reporting."

Robert T. Dawes, '26, "Alumni Fund Regional Chairman for Hudson, Mass.; Past President of the M.I.T. Club of Central Massachusetts; organizer of the Worcester meeting which last spring was a high point of the Association year."

Henry B. Backenstoss, '34, "President of his Class and Reunion Gift Chairman," whose "devoted and effective leadership over a period of five years resulted in the largest 25-year gift ever made by any class."

Thomas F. Morrow, '35, under whose "able and effective direction, the Detroit Regional Conference—14th in a notable and distinguished series—took place in January, 1959."

President Hanley presented a gavel to his predecessor in office, John J. Wilson, '29.

As chairman of the conference, F. Leroy Foster, '25, Director of the Division of Sponsored Research, presided at general sessions in both Cambridge and Chicago. Moderators at other sessions were (in Cambridge): Lewis D. Fykse, '41, Educational Council; D. Reid Weedon, Jr., '41, Class Agents; Dwight C. Arnold, '27, Special Gifts Solicitation; Frederick J. Kolb, Jr., '38, Class and Club Officers; John W. Kilduff, '18, Regional Solicitors; (and in Chicago) Philip L. Coleman, '23, Educational Council; Robert C. Meissner, '43, Special Gifts Solicitation; Robert S. Faurot, '44, Class and Club Officers; and Robert L. Silberman, '48, Regional Solicitors.

Speakers included: Frederick G. Lehmann, '51, Assistant Secretary of the Alumni Association; D. Hugh Darden, Executive Secretary of the Educational Council; Volta W. Torrey, Editor of The Technology Review; Robert M. Kimball, '33, Secretary of the Institute; Joseph E. Conrad, Director for Regions, Alumni Fund; Henry B. Kane, '24, Director of the Alumni Fund; and Donald P. Severance, '38, Secretary and Treasurer of the Alumni Association.

At the Cambridge meeting, demonstrations of applications of electronics to food technology were given by Samuel A. Goldblith, '40, Professor of Food Technology and Executive Officer of the Department; and of surveying with the speed of light, by Charles L. Miller, '51, Associate Professor of Surveying and Director of the Photogrammetry Laboratory Data Engineering Division, Department of Civil and Sanitary Engineering.

President Stratton entertained the conference delegates at his home, and a luncheon at the M.I.T. Faculty Club was addressed by B. Alden Thresher, '20, Director of Admissions.

The Chicago meeting was at the University Club, 76 East Monroe Street, and the delegates were greeted there by Harlan H. Davis, '40, President of the M.I.T. Club of Chicago.

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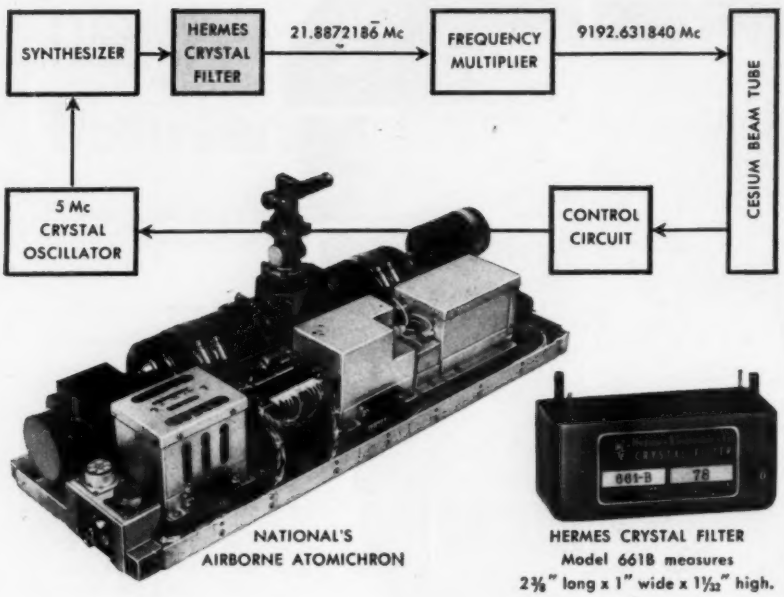

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Individuals Noteworthy

(Continued from page 10)

1959-1960 Visiting Professors

VISITING professors for the current academic year at the Institute are:

Carl T. Devine, in the School of Industrial Management, who received the M.B.A. and Ph.D. degrees from the University of Michigan, is now a professor at the University of Florida, and was on leave last year as professor at the University of California in Berkeley.

Donald J. White, in the School of Industrial Management, who was graduated from Boston College, received his M.A. and Ph.D. degrees from Harvard, and is on leave from Boston College, where he is associate dean and professor of economics in the College of Business Administration.

Terkel Rosenqvist, in the Department of Metallurgy, who is professor of extractive metallurgy at the Institute of Technology in Trondheim, Norway, his native land.

¶ Visiting associate professors this year are from England and Canada as well as the United States:

Roger J. Blin-Stoyle, in the Department of Physics, who is on leave from Oxford University in England, where he is a senior research officer in theoretical physics and a Fellow of Wadham College.

Murray C. Kemp, in the Department of Economics and Social Science, who is on leave from McGill University in Montreal, Canada.

Jerome Y. Lettvin, '47, in the Department of Biology, who is a consulting psychiatrist at the Boston Psychopathic Hospital and has been a member of the M.I.T. Research Laboratory of Electronics since 1951.

William W. Peterson, in the Department of Electrical Engineering, who is on leave from the University of Florida.

¶ A visiting assistant professor is James G. Clunie, in the Department of Mathematics, who is on leave from the Imperial College, University of London, in England.

(Continued on page 64)

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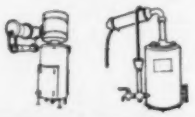

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Individuals Noteworthy

(Continued from page 62)

New Positions

MEN who have stepped into new positions in recent months include:

Louis S. Cates, '02, as a Director, Niagara Fire Insurance Company . . . *Rear Admiral Luis de Florez, '11,* as a Director, Douglas Aircraft Company . . . *George F. Halfacre, '18,* as Vice-president in Charge of Manufacturing, New Jersey Zinc Company . . . *Edwin D. Ryer, '20,* as a Director, Merchants Co-operative Bank, of Boston . . . *Zembry P. Giddens, '21,* as Executive Vice-president, of Dynamics Corporation of America . . . *Joseph L. Gillson, '21,* as President of the American Institute of Mining, Metallurgical, and Petroleum Engineers;

Harold E. Koch, '22, as Executive Vice-president, Basic Products Corporation, Milwaukee, Wis. . . . *William H. Lang, '22,* as a Director, Great Northern Railway . . . *H. W. McCurdy, '22,* as a Director, Lockheed Aircraft Corporation, and as Chairman, Puget Sound Bridge and Dredging Company;

Miles N. Clair, '23, as Vice-president, American Society for Testing Materials . . . *Cecil H. Green, '23,* as Trustee, Woods Hole Oceanographic Institution . . . *Gordon Y. Billard, '24,* as a general partner, Carreau and Company, New York . . . *John S. Davey, '24,* as Vice-president in Charge of Sales, Russell, Burdsall and Ward Bolt and Nut Company, Port Chester, N. Y. . . . *Carl F. Muckenhoupt, '24,* as Director of Research, Northeastern University;

F. Leroy Foster, '25, as a Director, Engineering College Research Council, American Society for Engineering Education . . . *James A. Drain, '26,* as Vice-president, H. K. Porter Company, Inc. . . . *James R. Killian, Jr., '26,* as a Director, General Motors Corporation, and as a Director, International Business Machines Corporation . . . *James G. Walker, '26,* as a Staff Manager, Johns-Manville Corporation;

Emerson W. Conlon, '29, as Assistant Director of Aeronautical and Space Research, National Aeronautics and Space Administration . . . *Lawrence C. Hamlin, '29,* as Regional Vice-president in Charge of Far East Operations, Standard-Vacuum Oil Company . . . *Joseph L. Speyer, '29,* as Secretary, Boston chapter, American Society of Chartered Life Underwriters;

Sidney McCuskey, '30, as Chairman, Department of Astronomy, Case Institute of Technology . . . *James B. Fisk, '31,* as a Trustee, John Simon Guggenheim Memorial Foundation, and as Chairman, Board of Directors, Newark College of Engineering Research Foundation . . . *Howard L. Richardson, '31,* as Executive Vice-president, The Stanley Works of New Britain, Conn., and as a Director, Taylor Instrument Companies, Rochester, N.Y.;

Arthur M. Marshall, '32, as a Member, Committee on Appointment, Interstate Commerce Commission Practitioners . . . *Paul F. Genachte, '33,* as a Director, Nuclear Science and Engineering Corporation, Pittsburgh, Pa. . . . *Francis T. Hall, Jr., '33,* as Head, Department of General Engineering, College of Engineering and Architecture, Pennsylvania State University;

(Concluded on page 66)

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Individuals Noteworthy

(Concluded from page 64)

Charles A. Cogan, '34, as Assistant Manager, Operations Division, Manufacturing Department, Standard Oil Company (Indiana) . . . *Jacob J. Jaeger, '34,* as President, Pratt and Whitney Division, Niles-Bement-Pond Company . . . *Frederick C. Johnson, '34,* as Vice-president and General Manager, Scale Division, Fairbanks, Morse & Company . . . *H. Neal Karr, '34,* as Head, Special Products Division, The Singer Manufacturing Company . . . *Robert K. Moore, Jr., '34,* as Superintendent of Lines and Substations, Pennsylvania Power and Light Company;

Isaac H. Munro, '35, as Vice-president, Marketing, Allied Chemical Corporation . . . *George S. Schairer, '35,* as Vice-president in Charge of Research and Development, Boeing Airplane Company . . . *Randolph M. Wilkens, '35,* as Sales Planning Manager, Industrial Products Division, Hewitt-Robins, Inc.;

William P. Kennedy, '36, as Assistant Director of Market Research, Lockheed Aircraft Corporation . . . *William M. Harcum, '37,* as General Manager, Eastern Research Center, Robertshaw-Fulton Controls Company . . . *Sidney Levine, '37,* as East Coast editor of *Ceramic Age;*

Robert V. D. Campbell, '38, as Director of Research, Paoli Laboratory, Burroughs Corporation . . . *Homer R. Oldfield, Jr., '38,* as Vice-president, Raytheon Manufacturing Company . . . *Reinhardt Schumann, Jr., '38,* as Head, School of Metallurgical Engineering, Purdue University;

John H. Howard, '39, as Manager, Paoli Laboratory, Burroughs Corporation . . . *Ernest R. Kaswell, '39,* as President, The Fiber Society, Inc. . . . *Lawrence M. Lyons, '39,* as Production Manager, Utility Industrial Division, Burndy Corporation . . . *Eugene Oliver, '39,* as General Foreman, Process Division, Humble Oil and Refining Company, Baytown, Texas . . . *A. Lindsay Thomson, '39,* as President and Treasurer, Terry Steam Turbine Company;

Richard C. Brown, '40, as Assistant Manager, Oakland Plant, American Can Company . . . *Samuel A. Goldblith, '40,* as a Director, Gorton's of Gloucester, Inc. . . . *Regis J. Harrington, '40,* as City Planner, Medford, Mass. . . . *Frank W. Lippard, '40,* as Assistant Manager, Quality Control Division, Philip Carey Manufacturing Company, Cincinnati, Ohio;

Walter J. Kreske, '41, as President, Massachusetts Society of Professional Engineers . . . *Kenneth G. McKay, '41,* as Vice-president in Charge of Systems Engineering, Bell Telephone Laboratories . . . *Nathaniel Rochester, '41,* as Manager of Experimental Machines Research, Mohansic Laboratory, International Business Machines Corporation . . . *Henry C. Vogel, '41,* as a Section Head, Project Development Department, Merck and Company, Inc. . . . *Teddy F. Walkowicz, '41,* as Director, Allied Research Associates, Inc. . . . *Albert F. Clear, Jr., '42,* as an associate, Booz, Allen and Hamilton . . . *Harvey I. Kram, '42,* as Vice-president — Operations, Revlon . . . *John W. McNall, '42* as Director of Research, Lamp Division, Westinghouse Electric Corporation.

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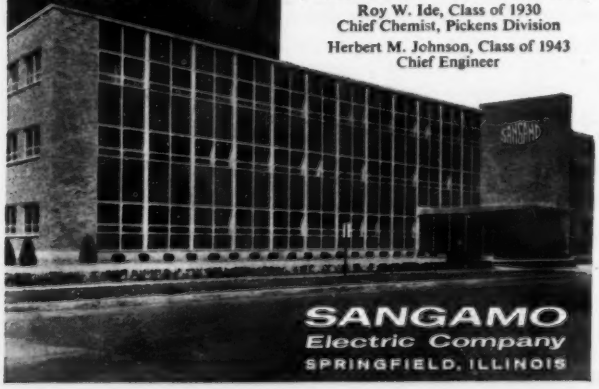

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The Coaches' Review

(Continued from page 34)

The most encouraging aspect of the year's play was the outstanding play of our sophomores. We had sophomores playing in the numbers one, two, three, six, and nine positions on the team. Next year, with our entire team returning, we look for a much better season. — Edward A. Crocker, Coach.

Rifle Team

M.I.T. riflemen participated in the New England Collegiate League and the Greater Boston Collegiate League.

In the N.E.C.R.L. Northern group, we were defeated by Norwich University and the University of Maine. Later in the season, M.I.T. and Maine were tied for second place. This resulted in another match for the two teams and M.I.T. was the victor. M.I.T. defeated Dartmouth, the University of New Hampshire, St. Michael's University, the University of Vermont, Harvard, and Bowdoin. In the New England finals, M.I.T. placed fourth, being defeated by Norwich, Providence College, and Coast Guard Academy.

In the Greater Boston League, M.I.T. lost only to Northeastern. M.I.T. defeated Harvard, Tufts, Boston College, and Wentworth Institute.

In non-league matches M.I.T. was defeated by Army and Navy. In the Coast Guard Invitational match M.I.T. placed ninth among 22 entries. The National Intercollegiate results showed M.I.T. placing 35th in a list of 217 teams.

This year M.I.T. entered a freshman team in the National Intercollegiate Freshman Team Match and placed 18th in the nation. — M/Sgt. James L. Bigham, U.S.M.C., Coach.

Pistol Team

The Pistol Team began its season in October with only one returning letterman and three other members of last year's team. From the men attending the pistol classes, the four most competent were added to the team roster, but one of these had to drop out.

The M.I.T. team normally fires in the North American Intercollegiate Pistol League but this league was not active this year so collegiate matches were limited to the Service academies. Although the team put forth a gallant effort, M.I.T. men were no match for the excellent shooters from West Point, Annapolis, and the Coast Guard Academy.

In the Greater Boston Pistol League, composed of teams from Harvard University and the Rod and Gun Clubs of Saugus, Parkway, Concord, Melrose, Mystic, Arlington, and General Electric, M.I.T. was in first place for the greater portion of the season and only lost out during the last month of competition. The season ended with 16 matches won and four lost. This put M.I.T. in third place, a good showing because the other teams were composed of men who had been firing for years. — Capt. Robert N. Strickland, U.S.A.F., Coach.

Varsity Golf

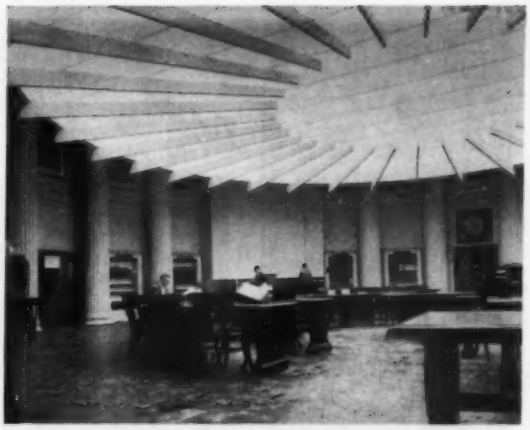
The team's record was three wins and 12 losses. We were fairly strong at the top two spots with Robert L. Rosenfeld, '59, and William R. T. Smith, '59, but the drop off after that was great. Rosenfeld was again a qualifier in the New Englands and was beaten by the eventual winner in the semifinal round. Next year several fine golfers are moving up from the freshman squad. — John H. Burke, Jr., Coach.

Track Team

The M.I.T. Track Team completed its season with a 2-and-7 record. Wins over New Hampshire, both indoors and outdoors, were chalked up against losses to West Point, Bates, Connecticut, Bowdoin, Springfield, Tufts, and Brown.

(Continued on page 70)

Chandeluminaire in Central Library, M.I.T. Weighing 16 tons, this fixture hangs 51 feet from the original dome ceiling and delivers 75 footcandles at desk surfaces.



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The Coaches' Review

(Continued from page 68)

Hampered seriously by the weather and a dearth of experienced runners and fieldmen, the indoor season win over the University of New Hampshire proved that spirit and enthusiasm ran high. The relay team, comprised of Daniel J. Thomas, '59, Robert W. Slusser, '60, George L. Withbroe, '61, and James W. Poitras, '61, finished third in the B.A.A. Games. The team also participated in the Tufts Open Meet and the New England A.A.U. Championships.

The outdoor season, with three dual meets, a triangular meet, and participation in the Eastern and New England championships, saw renewed interest and some fine competition by the M.I.T. cindermen. With only two seniors, John G. Maier, '59, and Charles O. Staples, '59, to call on, the team relied on juniors and sophomores.

Outstanding for M.I.T. this year and returning next season were: Joseph T. Davis, '61, in the hurdles and high jump; Donald G. Morrison, '61, in the sprints and broad jump; Withbroe and Slusser in the 440; Brian E. White, '61, in the 880 and mile; Paul T. Robertson, '61, and Herbert H. Grieves, Jr., '61, in the distance runs; Captain William J. Nicholson, '60, in the hammer throw; James R. Long, '60, in the weights; and Nathan A. Liskov, '60, in the pole vault. Arhtur S. Warner, '60, a transfer, was a welcome addition to the hurdles and high jump. Others who helped considerably were Robert L. Mullen, '60, Edward O. McCartney, '60, Rollyn G. Graham, '60, Dan R. McConnell, '61, Garrick A. Gustafson, '61, Robert P. Barrett, '60, Will Kenigsburg, '61, and Mannie Smith, '61.

Freshmen (Class of 1962) who should be welcome additions to the varsity next year include: David H. Koch, who established a new Frosh pole vault record; Neil L. Bacote,

(Continued on page 72)

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22 Shld.	19/34	.075	.140	.240	.255	.260	.305
20	19/32	.085	.135	.220	.250	.270	.320
20 Shld.	19/32	.085	.155	.240	.270	.290	.335
18	19/30	.090	.140	.245	.260	.285	.335
18 Shld.	19/30	.090	.155	.270	.285	.310	.385
16	19/29	.105	.160	.265	.290	.315	.380
16 Shld.	19/29	.105	.175	.285	.310	.335	.400
14	19/27	.135	.185	.360	.385	.415	.500
14 Shld.	19/27	.135	.225	.390	.415	.445	.530
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The Coaches' Review

(Continued from page 70)

a sprinter who broke the Frosh record in the broad jump; Stephen J. Banks in the distance runs; Val Silbey and Joseph E. Crowley, hurdlers; Thomas G. Burns and William I. Koch in the 440; Harold C. Frazier, Jr., and Lawrence A. Coppola in the 880; and weightmen David L. Butler, Bardwell C. Salmon, Charles E. Rein, Peter C. Ommundson, and Edward B. Feinberg. — Arthur E. Farnham, Jr., Coach.

Varsity Baseball

The M.I.T. baseball season opened with a spring vacation trip. Twenty eager ballplayers journeyed to New Brunswick to open the season against Rutgers University. In one of the best-played games of the season, M.I.T. defeated Rutgers 2–1, behind John C. Blinn's ('61) two-hit pitching. The last inning was a spine-tingling experience. Captain Warren H. Goodnow, '59, who caught the first eight innings and singled home the winning run in the eighth inning, relieved sophomore Blinn in the ninth inning with men on second and third, no outs, and proceeded to retire the next three Rutgers batters to preserve the victory. The team closed out the trip with two close losses to Catholic University and Johns Hopkins.

Although finishing with a one-and-five record in the Greater Boston League, the team lost two heartbreaking games: Harvard 0–3, and Northeastern 0–2. Brandeis was defeated 6–2; Boston University, Boston College, and Tufts took the measure of the varsity men in the league competition. Outside the Greater Boston League the team chalked up victories over Bowdoin, Bates, Clark, and Coast Guard, and lost to Worcester Polytechnic and Wesleyan.

The 1959 Baseball Team was one of the strongest to represent M.I.T. since the first season's play in 1949. The leadership of Captain Goodnow, Greater Boston League All Star Selection as a junior and senior, was a key factor in the team's strong performance. Harold J. Parmelee, '60 transfer from Bowdoin, was selected on the Greater Boston All Star team at second base, and his general all-around play highlighted the M.I.T. individual hitting and fielding statistics. Albert L. Beard, '59, a three-year veteran, Elliot N. Fineman, '59, Jack M. Pogarian, '59, Walter J. Humann, '59, and Thomas H. O'Connor, Jr., '60, will be missed next year. — Robert M. Whitelaw, Coach.

Varsity Wrestling

The Wrestling Team started out last December by winning a decisive victory over Tufts University, losing only two of the eight individual matches. Then "old man injury" took over and we never had the original eight starters on the mats again at the same time. Nevertheless, we managed to beat the University of Massachusetts, but dropped decisions to Harvard, Springfield, the U.S. Coast Guard Academy, Dartmouth, and Wesleyan.

Six of the eight starters last December were sophomores and the others were juniors. Therefore we cannot help but be a little optimistic for next year. — Alex Sotir, Coach.

Fencing Team

The first half of the season went well, as Boston University, Bradford-Durfee Tech, Syracuse, and Holy Cross were soundly beaten, Trinity College was edged, and a hard-fought match was dropped at Cornell. The second half of the season, however, saw a sharp reversal of form not wholly related to the higher caliber of our opposition. Even so, the Fencing Team preserved its record of never going beneath .500. The record for this season was: six won, five

(Concluded on page 74)

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The Coaches' Review

(Concluded from page 72)

lost, second place team in the New England Intercollegiate Championships (by five points).

I believe that the lack of familiarity with the new electric foil hurt our chances, and for a time the varsity was fencing four difficult meets two or three days apart. This made it difficult to stay at peak condition. – Silvio Vitale, Coach.

Freshman Swimming

This was probably one of the greatest freshman swimming years at M.I.T. Team spirit and the desire to win was high throughout the season and contributed greatly to the record of 7 wins and 2 losses. The team established six new M.I.T. freshman records. The highlight of the season's schedule was the victory over a strong West Point squad.

Freshman Basketball

The freshman basketball record reads: four wins and seven losses for the 1958–1959 season.

Freshman Lacrosse

The Freshman Lacrosse Team was handicapped by the usual problems: Only two boys, both goalies, had played before.

Freshman Squash

The season opened with a 5–4 win over Army at West Point, but the superior experience of preparatory school opponents won the next six matches.

Freshman Wrestling

The Freshman Wrestling Team had some of the most experienced and seasoned performers that M.I.T. has obtained in some time, but the team was incomplete all season. We lacked one and sometimes two weight classes in each meet.

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Institute Yesteryears

25 Years Ago . . .

DESPITE the continuing effects of the "great depression," the Institute entered upon the new academic year of 1934–1935 in a spirit of trustful optimism that the worst of it might be over.

For, although opening-day registration totaled 2,511, which was a decline of 95 compared with the previous year, freshmen numbered 549 (up 64) and entering graduate students numbered 267 (up 37). These latter 267 brought current enrollment in the Graduate School to 499, thus justifying the conversion during the previous summer of three more dormitory units — Ware, Atkinson, and Runkle — for addition to the original Graduate House group.

¶ Moreover, the first Annual Report of Horace S. Ford as Treasurer of the Institute, covering the fiscal year 1933–1934, "evoked comments of approbation and satisfaction," observed the Review editors, "for out of the necessary welter of schedules running almost the entire gamut of the alphabet and occupying 74 pages of 8-point type, emerged the salient fact that the Institute had completed another year on the proper side of the ledger."

¶ Among the new members welcomed by the Faculty in the autumn of 1934 were: Professors Warren J. Mead and Walter G. Whitman, '17, as Heads, respectively, of the Departments of Geology and Chemical Engineering; Associate Professor Joseph H. Keenan, '22, in the Department of Mechanical Engineering; and Assistant Professors Francis Bitter and Robley D. Evans, respectively, in the Departments of Mining Engineering and Metallurgy and of Physics.

50 Years Ago . . .

REGISTRATION for 1909–1910 totaled 1,479, including "31 research fellows and other candidates for advanced degrees, against 26 last year."

¶ In commenting upon *The Tech* having become in 1909–1910 a daily newspaper, The Review said: "The subscription price remains at $1.50 per year; the price of a single issue is one cent. The paper is very creditable, although some improvements can be made. . ."

(Concluded on page 78)

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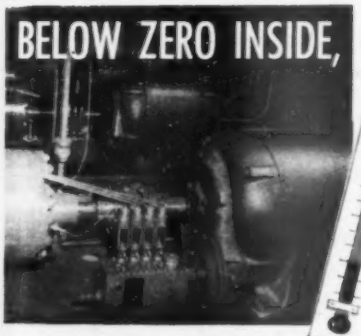

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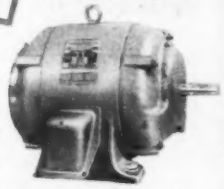

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Institute Yesteryears

(*Concluded from page 76*)

75 Years Ago . . .

FOR 1884–1885, registration totaled 579, an increase of 136, or 31 per cent, over 1883–1884. There were 193 freshmen of the Class of 1888, nearly one-third more than had entered with the Class of 1887 in the previous autumn.

¶ Treasurer John Cummings, in his Annual Report for the fiscal year ending September 30, 1884, recorded that current income of $123,409 had been $40,686 less than the expenses of $164,095. Invested assets were $346,313, and the book value of the educational plant stood at $631,810.

¶ From *The Tech* of November 5, 1884: "The final demonstration in Boston of the Presidential campaign was the Republican torchlight procession, which took place the night before election. In it the Institute, as has been its custom, took part. . . .

"The Committee, to whom a mass meeting of students had given control, provided uniforms, each consisting of a loose robe of gray cloth trimmed with cardinal . . . a close-fitting breast-piece, gray, displaying the year of the class to which its bearer belonged, a mortar-board in the same colors, with a white tassel falling from its brilliant cardinal surface, and a torch. . . .

"The regiment, headed by its own fife and drum corps and the Boston Cadet Band, formed near the gymnasium. . . .

"Transparencies, in considerable numbers, were carried, their sentiments varying through a wide range. The principal one was a massive affair, on which appeared the name of the school, the presidential preferences, as canvassed, *viz.*, Blaine, 371; Cleveland, 156; St. John, 18; Butler, 1; Belva, 1; and the inscription –

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"Observers have said that the tendency of the Techs was to over-sedateness. . . ."

99 Years Ago . . .

AN APPLICATION, in the handwriting of William Barton Rogers, was made to the General Court of the Commonwealth, in which he and 18 other "subscribers [did] respectfully pray for an Act of Incorporation for an Institution to be entitled MASS. INSTITUTE OF TECHNOLOGY." On November 20, 1860, the Secretary of State approved this application for publication in the *Boston Daily Advertiser* after which it was forwarded for action by the General Court when that body assembled the following January.

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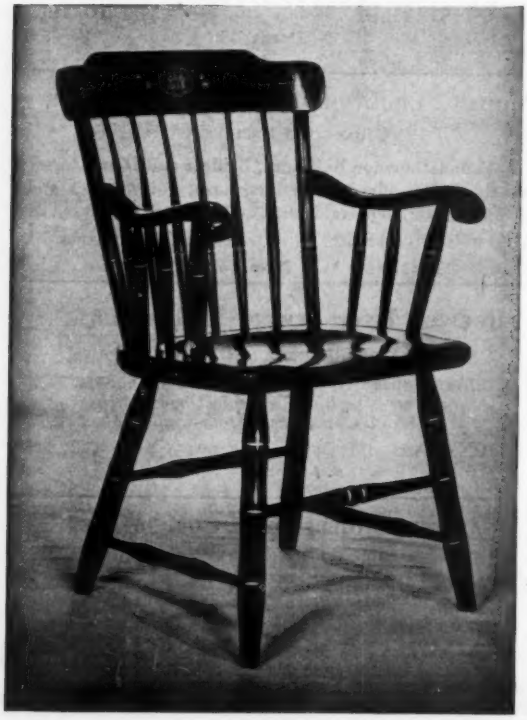

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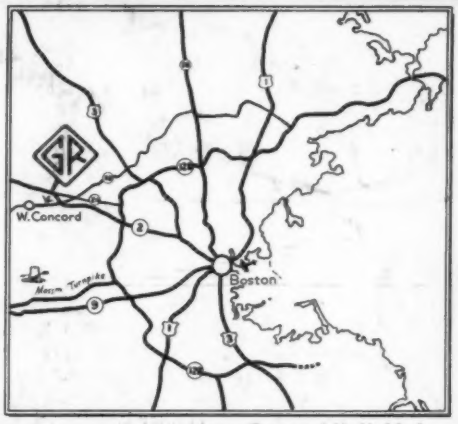

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